Air Force Materiel Command

Developing, Fielding, and Sustaining America's Aerospace F

Presentation to: NDIA 20th Test & Evaluation Conference

Effectively Using (and Accrediting) Modeling and Simulation (Especially Hardware-In-The-Loop) for OT&E

4 March 2004

U.S. AIR FORCE

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Integrity - Service - Excellence

Outline

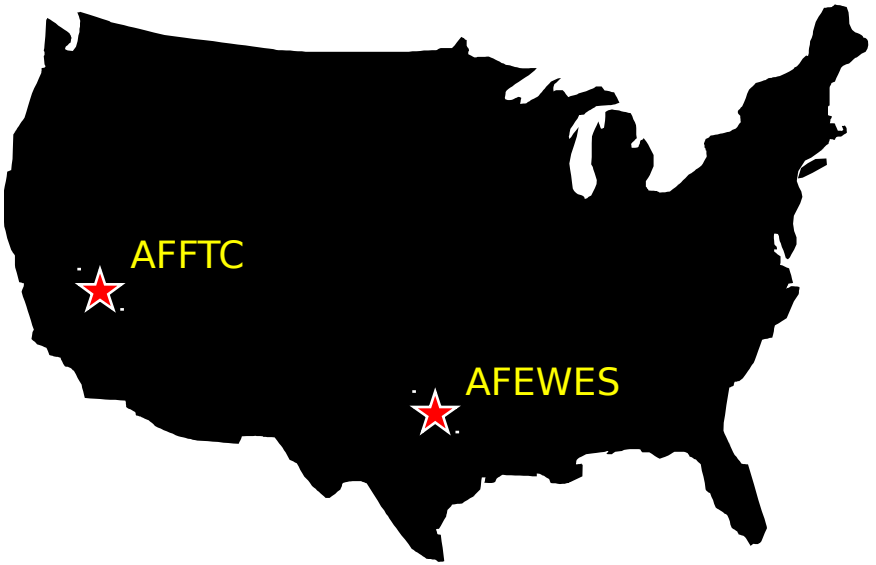
- **AFEWES Overview**
- **Choosing Tools for EW T&E**
  - Premises
  - Considering the IRCM Case
- **Assessing Available Tools: the IRCM Case**
  - Utility
    - Strengths
      - Limitations
- **Fidelity: How much is enough?**
- **Verification Validation & Accreditation**
  - Tools
  - AFOTEC Accreditation of AFEWES
  - Sensitivity Analysis
- **Conclusions**

Air Force EW Evaluation Simulator

Organization / Location

AFEWES is an Operating Location of Air Force Flight Test Center (AFFTC), Edwards AFB, California

- AFEWES reports to AFFTC/EW Directorate
- AFEWES facility is located at Air Force Plant 4, Ft. Worth, TX



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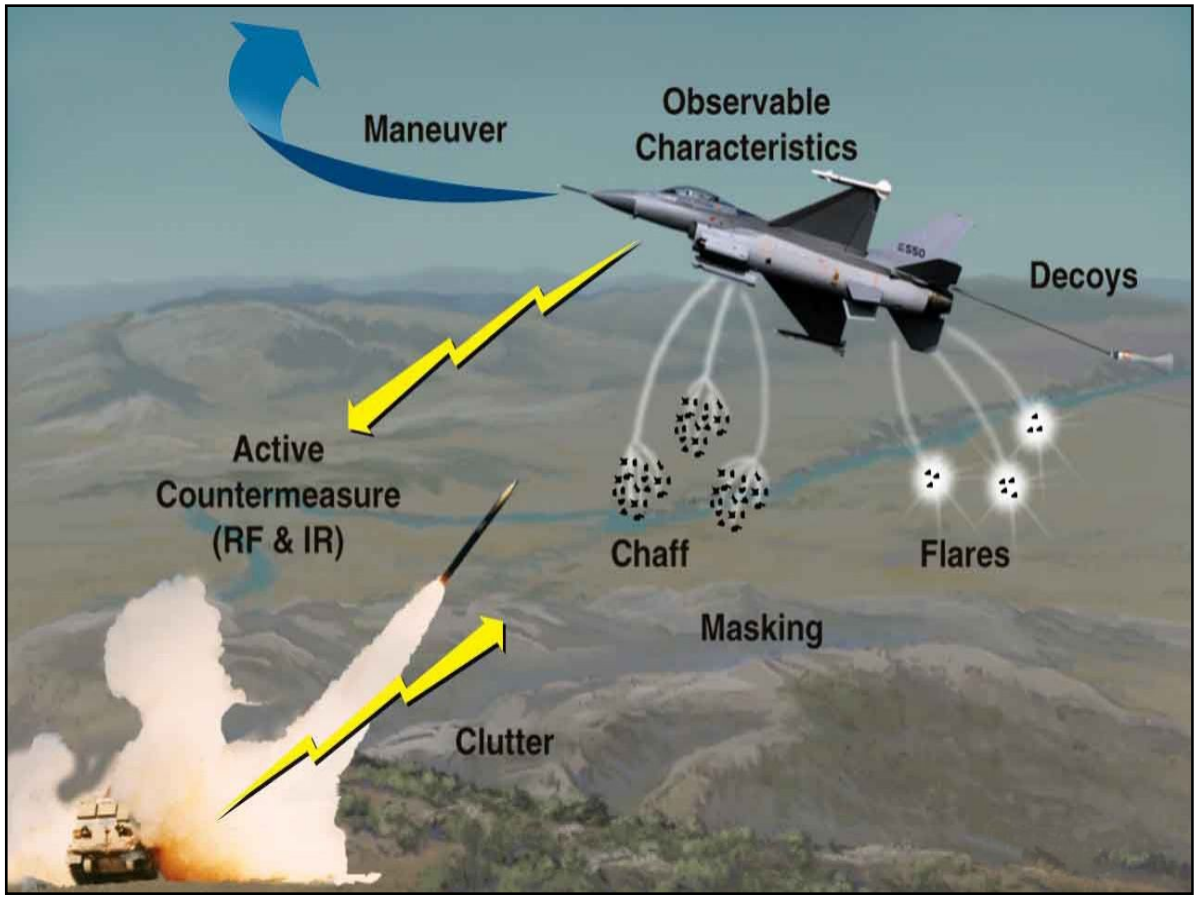
AFEWES Mission



Perform effectiveness and/or integration testing of electronic warfare systems and techniques in a simulated Infrared (IR) and Radio Frequency (RF) threat environment.

AFEWES Supports U.S. and Allied Governments' Quest for Increasing Aircraft Survivability

AFEWES Threat Simulations

RF Simulations:

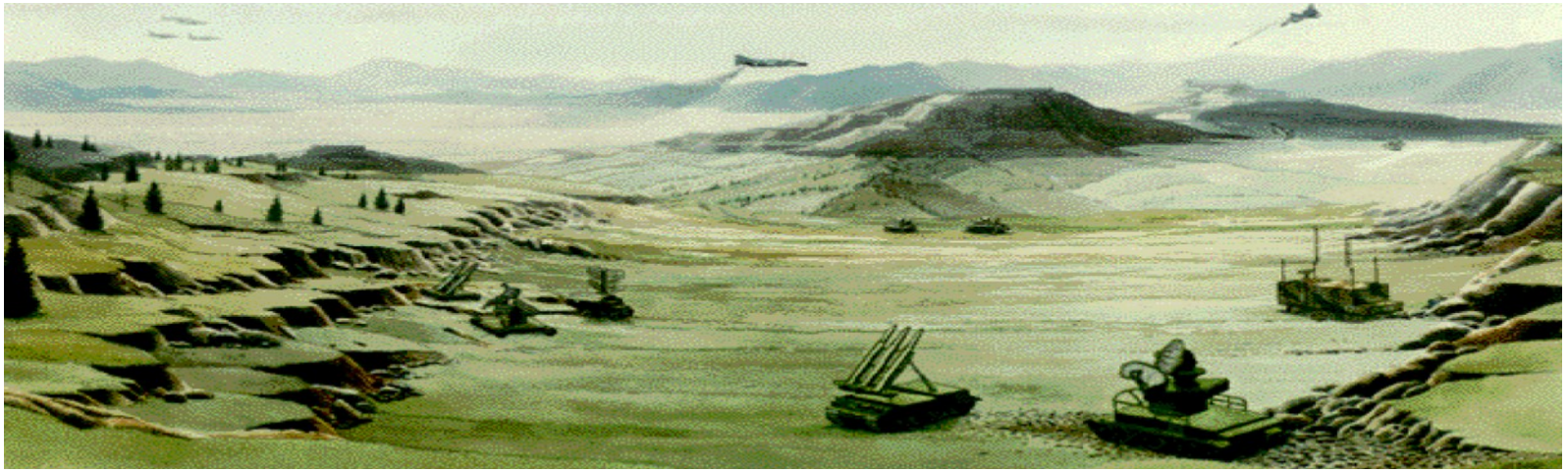
High-fidelity simulations of essentially all semi-active RF SAMs which pose a threat to US and allied aircraft:

- Classic Semi-Active Guidance
- Seeker-Aided Ground Guidance (SAGG)

IR Simulations:

High-fidelity simulations of most IR threats faced by US and allied aircraft:

- Red and Gray MANPADS
- IR Air-to-Air Missiles
- Vehicle-Mounted IR SAMs



Testing is Accomplished Using High-Fidelity Hardware-in-the-Loop (HITL) Threat Simulators

EW Systems/Techniques Evaluated

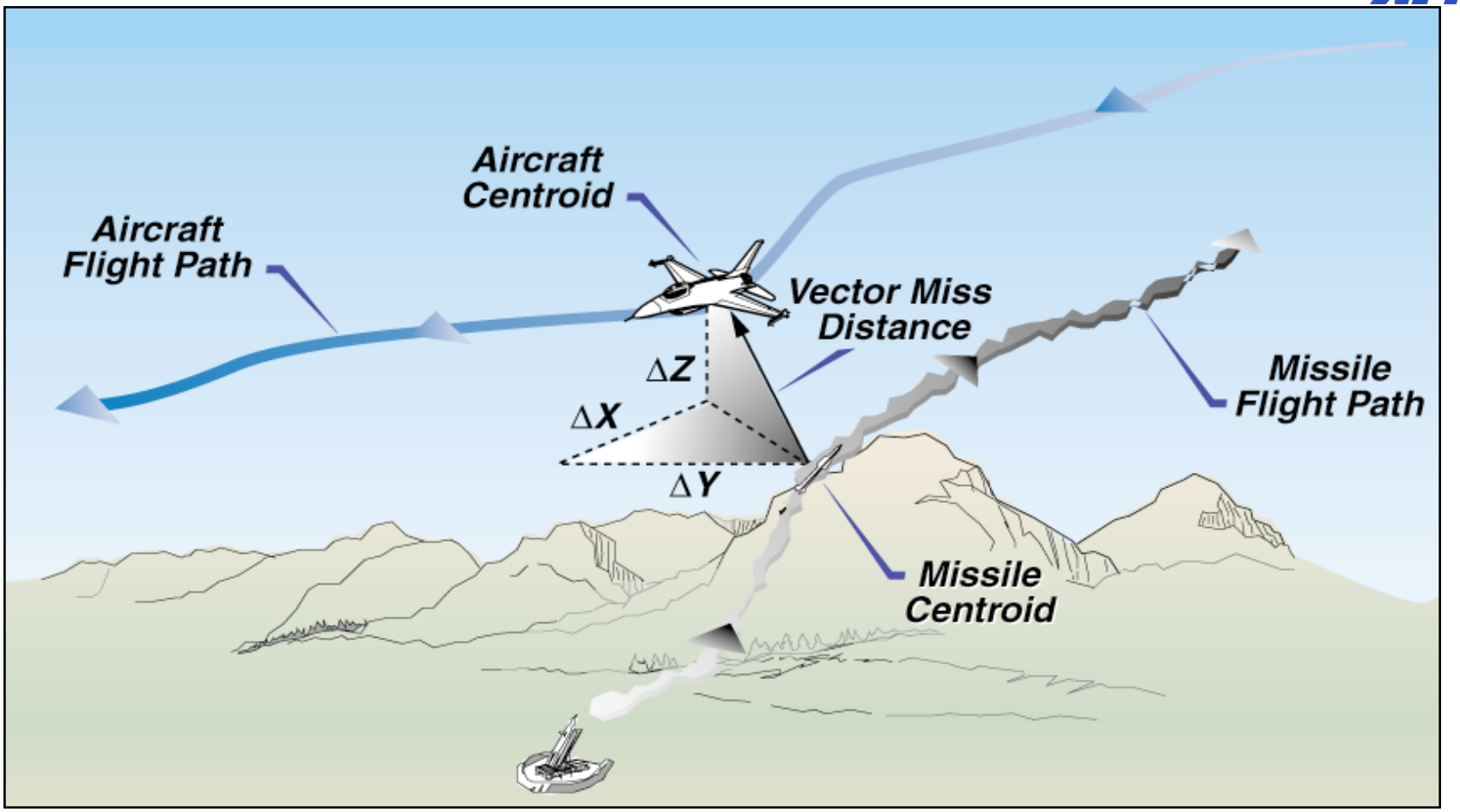
- ✓ **Onboard RF Jammers**
- ✓ **Towed Decoys**
- ✓ **Radar Warning Receivers**
- ✓ **Self-Protect Chaff**
- ✓ **Integrated RWR & Countermeasures**
- ✓ **Aircraft Maneuvers**
- ✓ **IR Jammers**
  - **Lamp**
  - **LASER**
- ✓ **Flares**
  - **Conventional**
  - **Thrusted**
  - **Aerodynamic**

- ➢ **Real-time, actual frequency/wavelength**
- ➢ **Fully dynamic engagements**
- ➢ **Dense signal environment (RF/MMW)**
- ➢ **Concept through actual hardware evaluat**
- ➢ **Certified as HLA-compliant**
- ➢ **Same day test data availability**

AFEWES Evaluates Developing and Mature EW - - from System Concept Through Deployed Hardware

AFEWES Simulation

Precise Vector Geometry

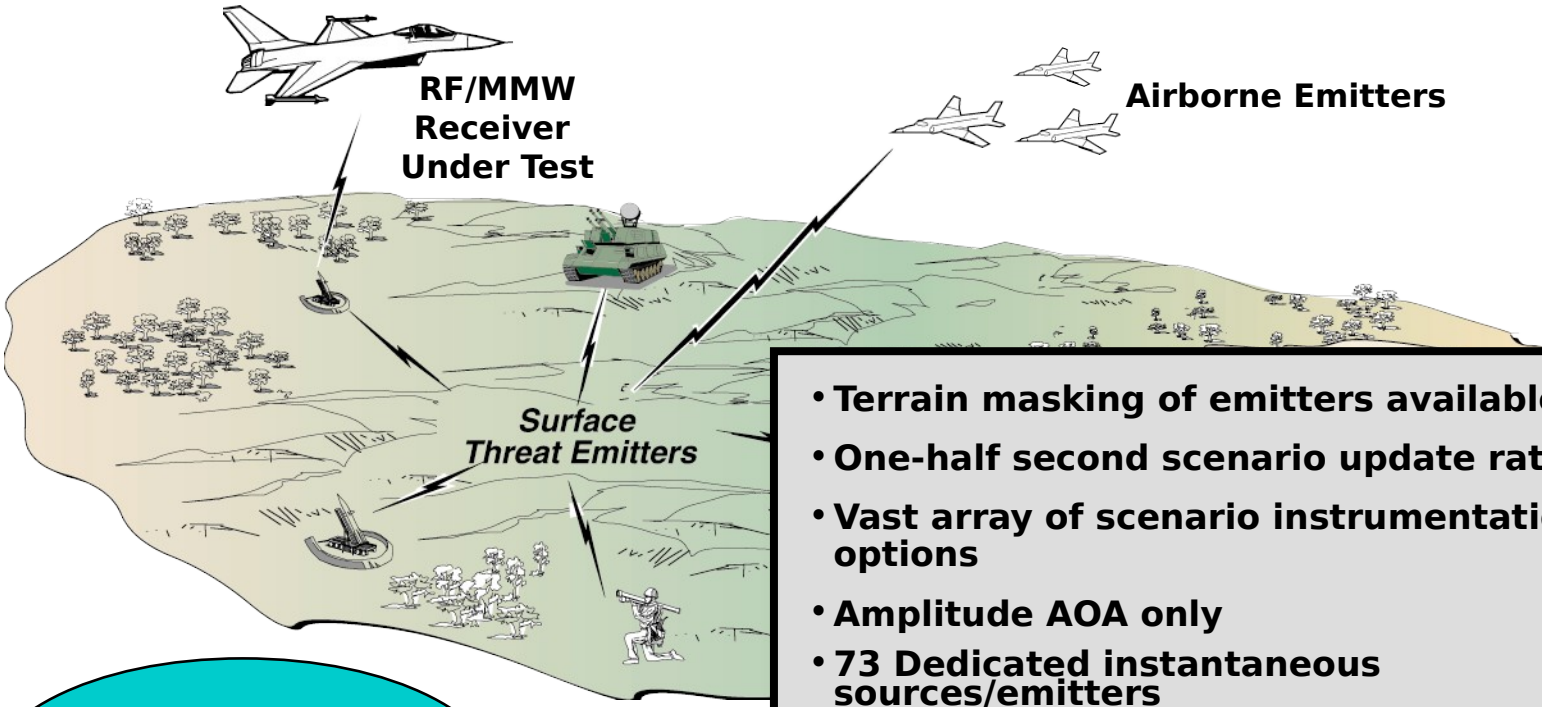


Accurate Vector Geometry is Necessary to Understand IR and RF Engagement Outcomes

AFEWES Test Capabilities

Radio Frequency (RF) Test Capabilities

RF Open-Loop System Testing



- Terrain masking of emitters available
- One-half second scenario update rate
- Vast array of scenario instrumentation options
- Amplitude AOA only
- 73 Dedicated instantaneous sources/emitters
  - Up to 20 complex waveform (PD) sources
  - Multiplexing expands capability to 217 emitters
  - Hostile, neutral and friendly signals
- RF coverage 0.5 to 18.0 GHz plus MMW
  - (30 – 40; 90 – 100 GHz)
  - Up to 8 RF outputs to system under test

RWR performance
comm links
system degradation

Versatile, Realistic Dense RF Environment

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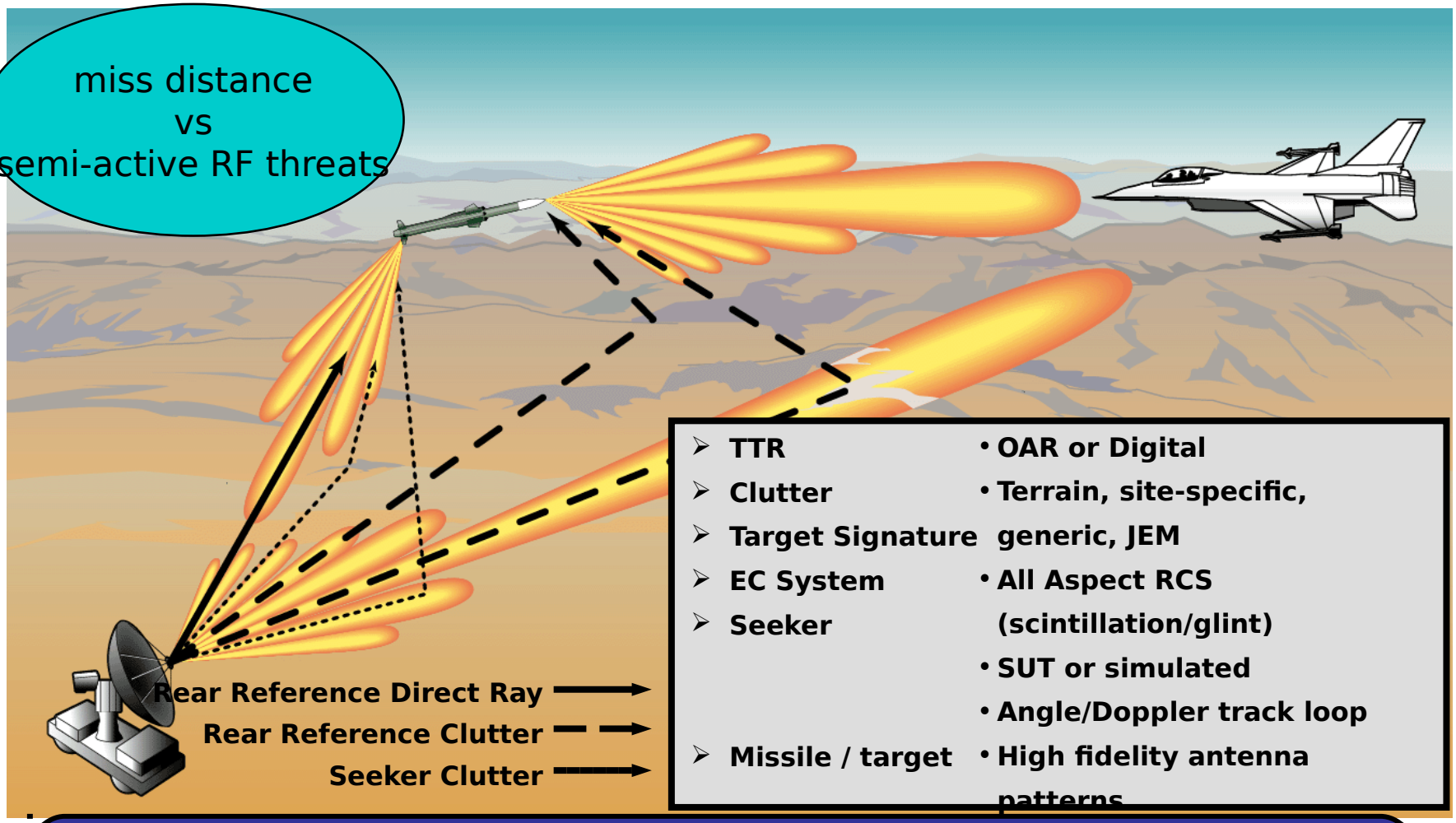
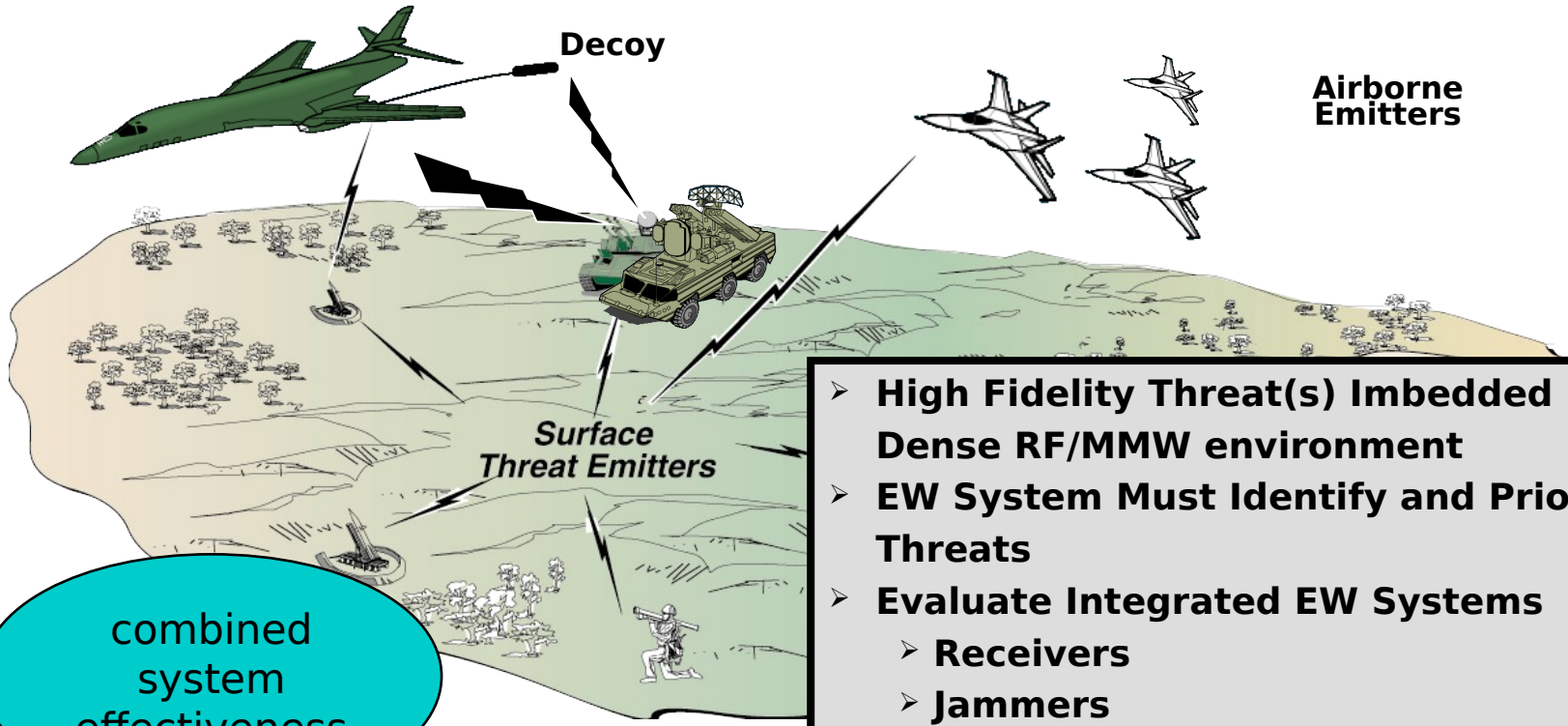
RF Closed-Loop System Testing

AFMC



Simulation Attributes Provide Engagement Fidelity with High Throughput (100+ runs/day)

RF Combined Open and Closed-Loop System Testing



combined system effectiveness

- High Fidelity Threat(s) Imbedded in Dense RF/MMW environment
- EW System Must Identify and Prioritize Threats
- Evaluate Integrated EW Systems
  - Receivers
  - Jammers
  - Expendables
  - Maneuvers

EW System Effectiveness is a Function of Battlefield Environment

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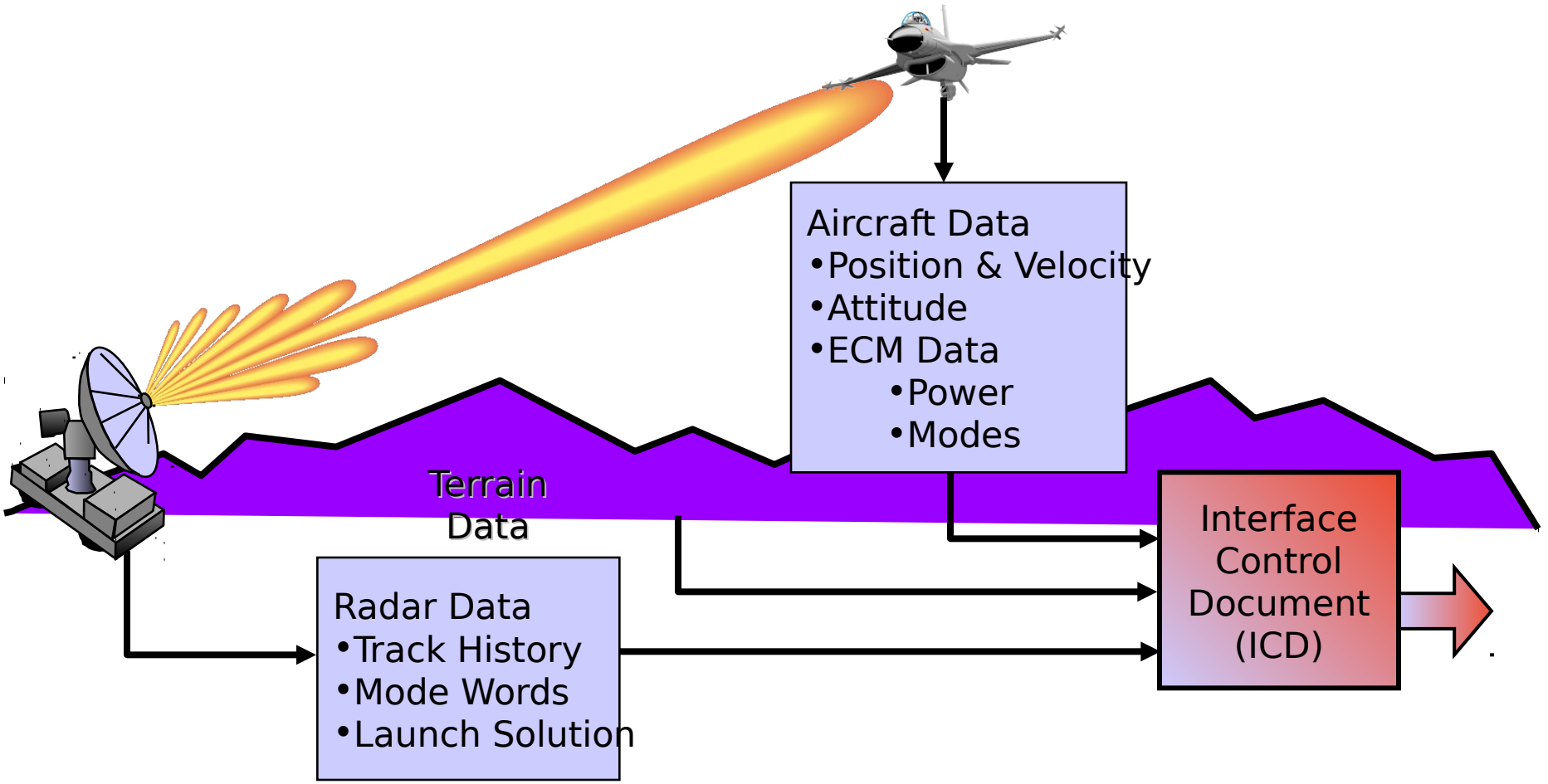
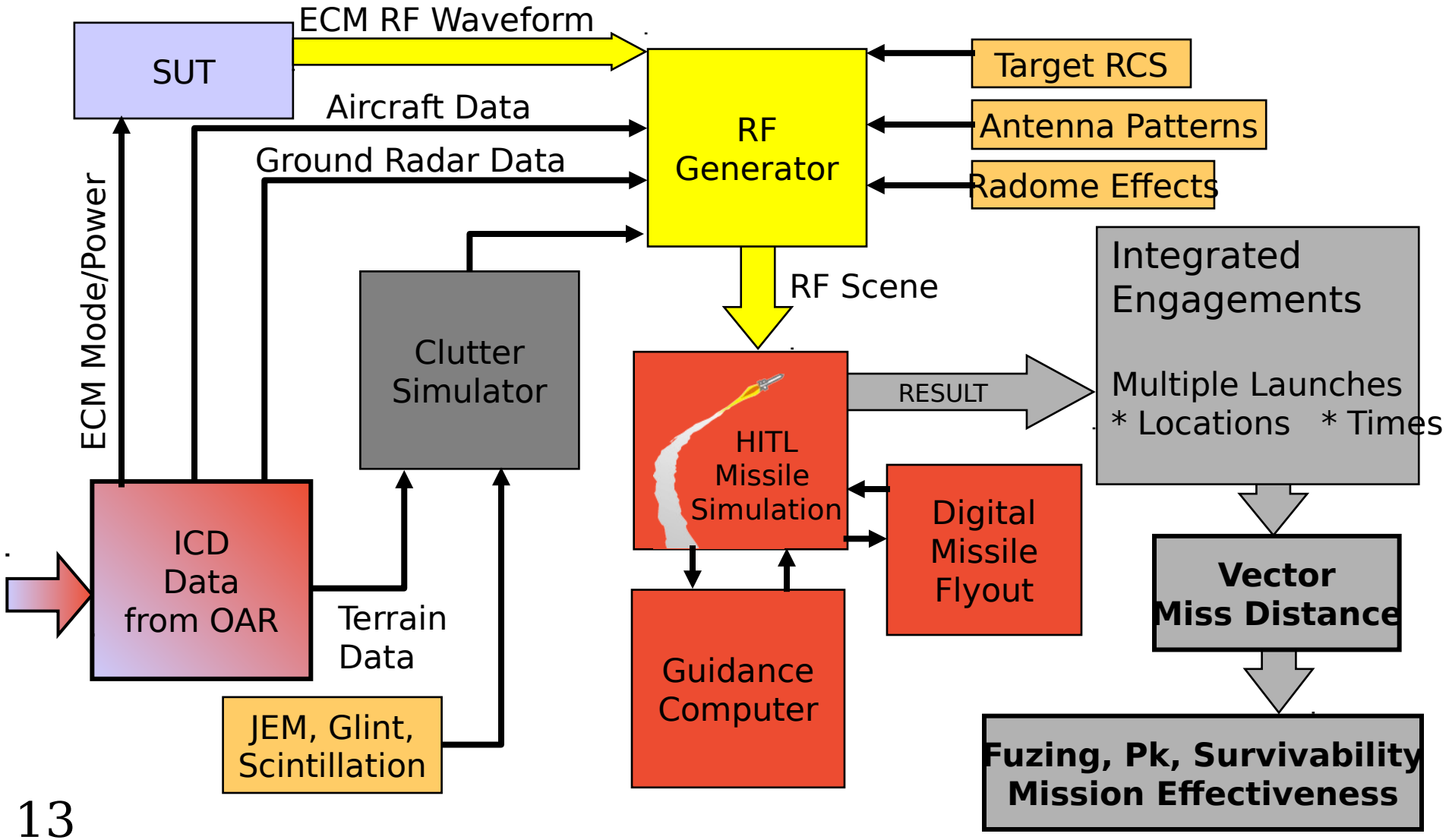
Integrated OAR - HITL Test Concept

The OAR piece



Integrated OAR - HITL Test Concept

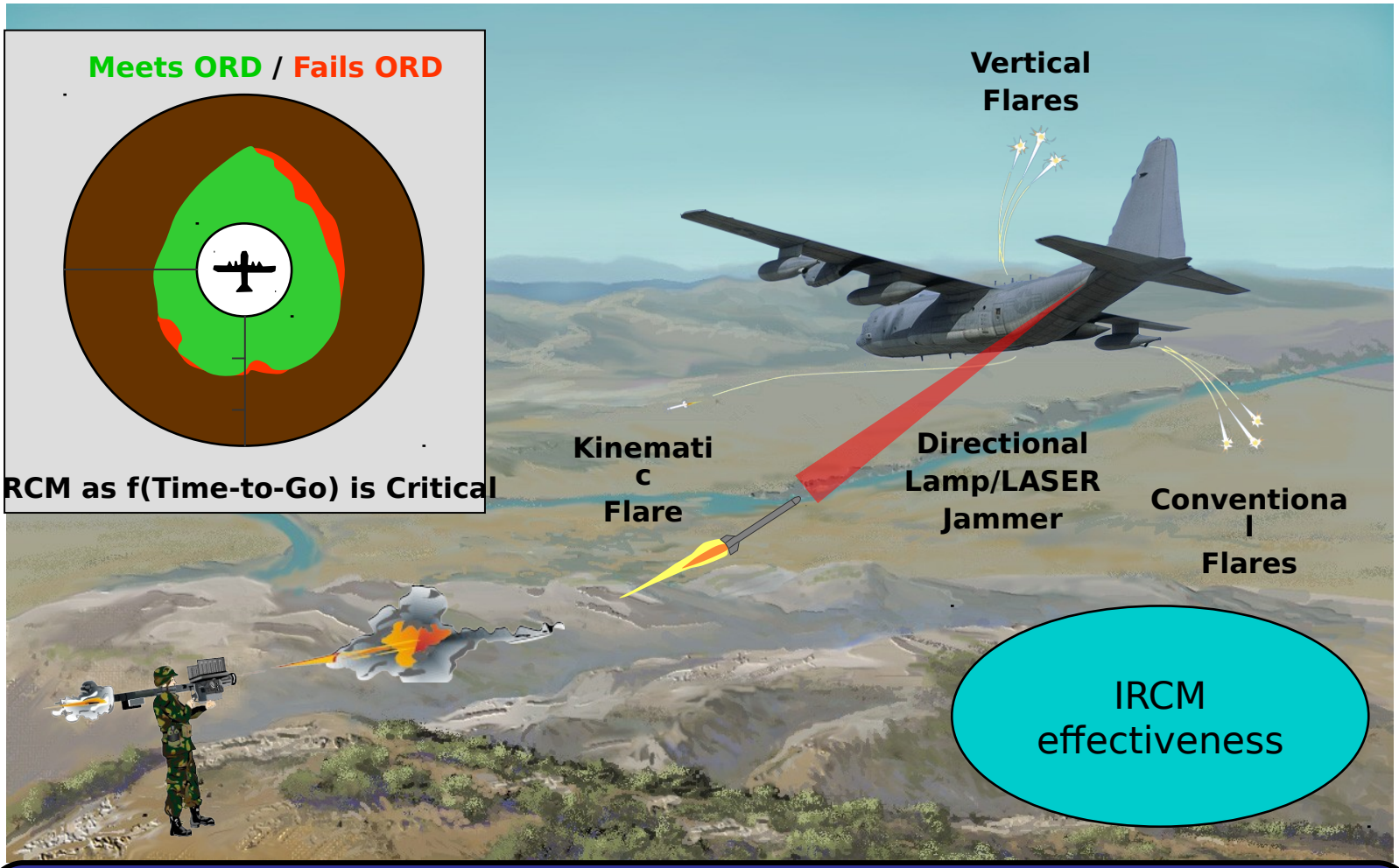
The HITL piece



AFEWES Test Capabilities

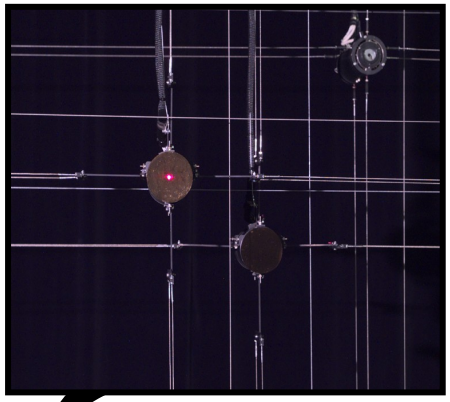
Infrared (IR) Test Capabilities

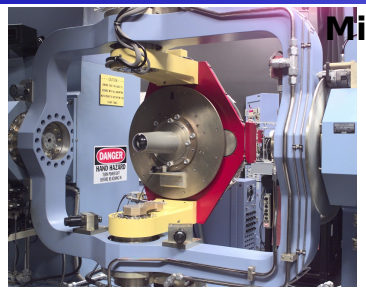
AFEWES IR System Testing



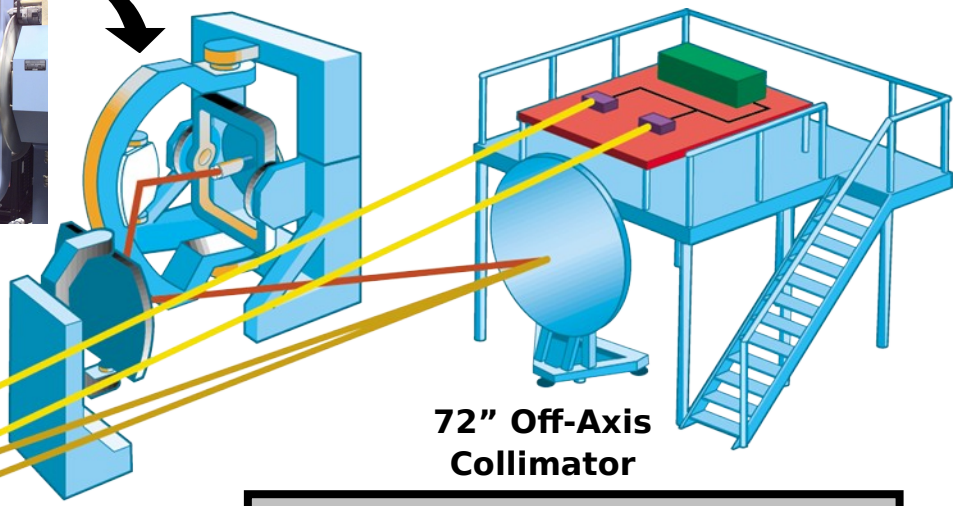
AFEWES Evaluates Countermeasure Techniques to Determine Effectiveness and Optimize Flare Timing, Jam Codes, etc.

AFEWES IR Test Approach

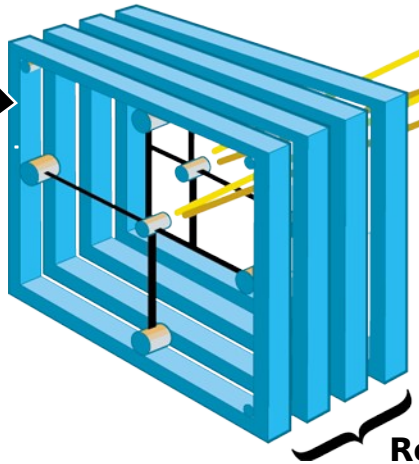




Missile seeker on Flight Motion Table



72” Off-Axis Collimator



High Frequency Response Foreground (8 independent sources)

Capabilities:

- Up to 8 Arclamp / Blackbody Sources
- Multiple LASER Source Locations on Target Aircraft
- Individual Power / Shadow Control
- Moving Fiducial Point Tracking (for Large Aircraft)
- Integration of Actual LASER CM Hardware Possible
- Real-time Missile /Target Kinematics

Simulation Attributes Provide Engagement Fidelity with High Throughput (100+ runs/day)

AFEWES IR Direction

- **Development of New AFEWES IR Background**
  - 512x512 Honeywell Resistor Arrays
    - ~ 180 Hz refresh rate
    - ~ 700 degree Kelvin apparent pixel temperature
- **Planned Optical Combination of New IR Background with Existing IR Foreground**
  - Preliminary mechanical / optical designs complete
  - Array acceptance March 2003
- **IR Scene Generation**
  - Phase II SBIR with Kinetics Inc
- **Registration and synchronization with existing high intensity arc-lamp / blackbody / laser foreground sources to address dynamic range limitations**
- **Partnering with AF Research Lab, MSIC**

Enhanced Background -- Extended Source Targets, Complex Targets, IR Clutter, Area Flares, Low Observables

Choosing Tools for EW T&E

- Premises
- Considering the IRCM Case

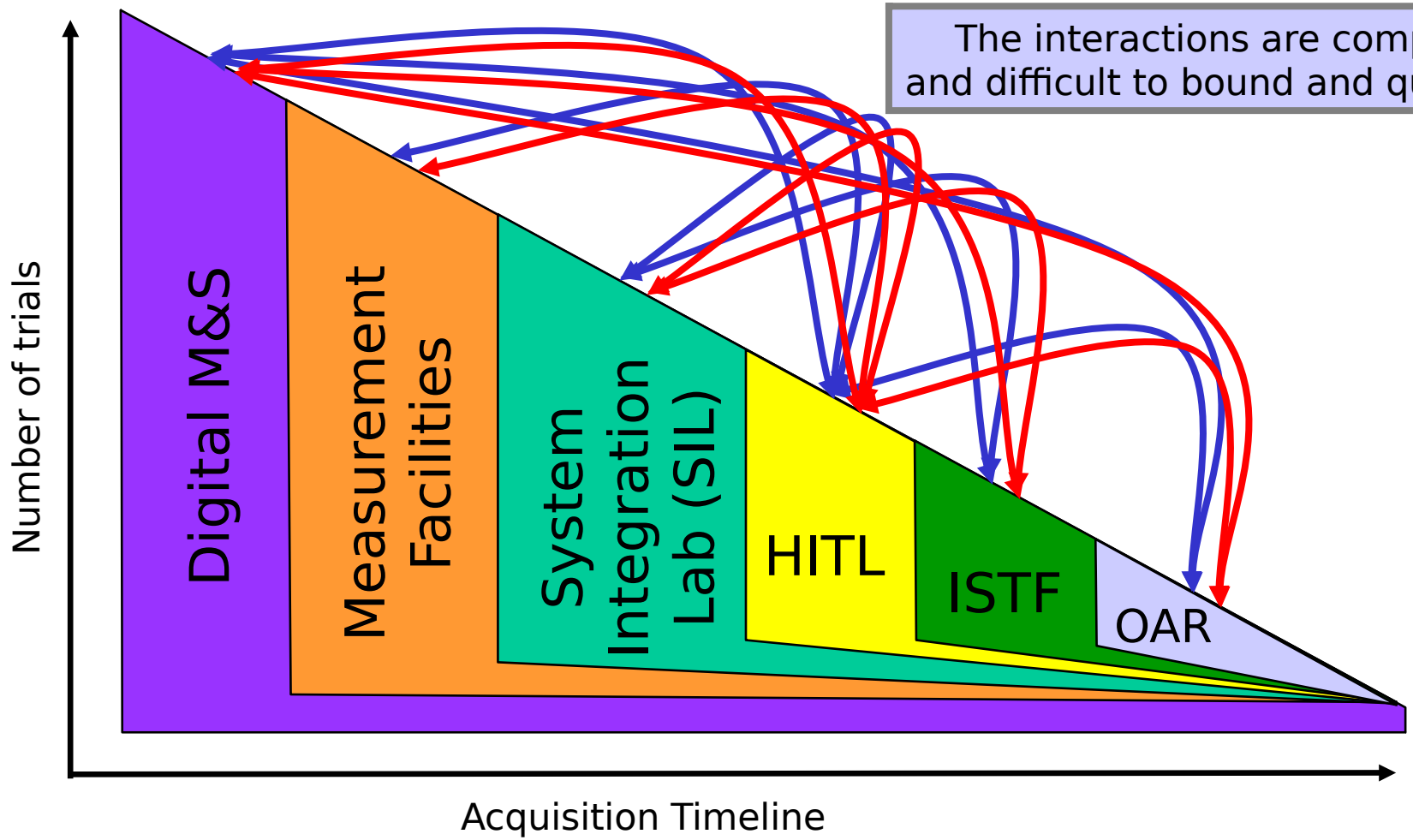
Choosing Tools for EW T&E

Premises

- Anything short of war is simulation
- No simulation is sufficient in and of itself
- Accurate assessment of tool strengths and limitations enables more effective analysis
- A fool with a tool is still a fool

Case Study: IRCM Effectiveness Evaluation

EC Test Process



Choosing Tools for EW T&E

Assessing Available Tools: the IRCM Case

- Utility
  - Strengths
    - Limitations

IRCM Effectiveness Evaluation

the closed loop

Atmospheric Effects

Target Signature

Aircraft Structure
Background
Hot Parts
Plume

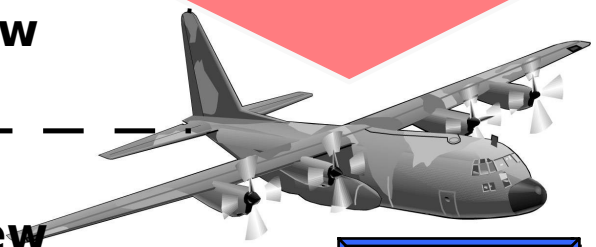
Missile Performance

Seeker Performance
Aerodynamics

Target Defensive Systems

IR Jammers
Electronics
Flares

Missile Point of View



Aircraft Point of View

Missile Signature

Background
Hardbody
Plume

Missile Warning Performance
System Processor
Pointer / Tracker

Aircraft Sensors / Electronics

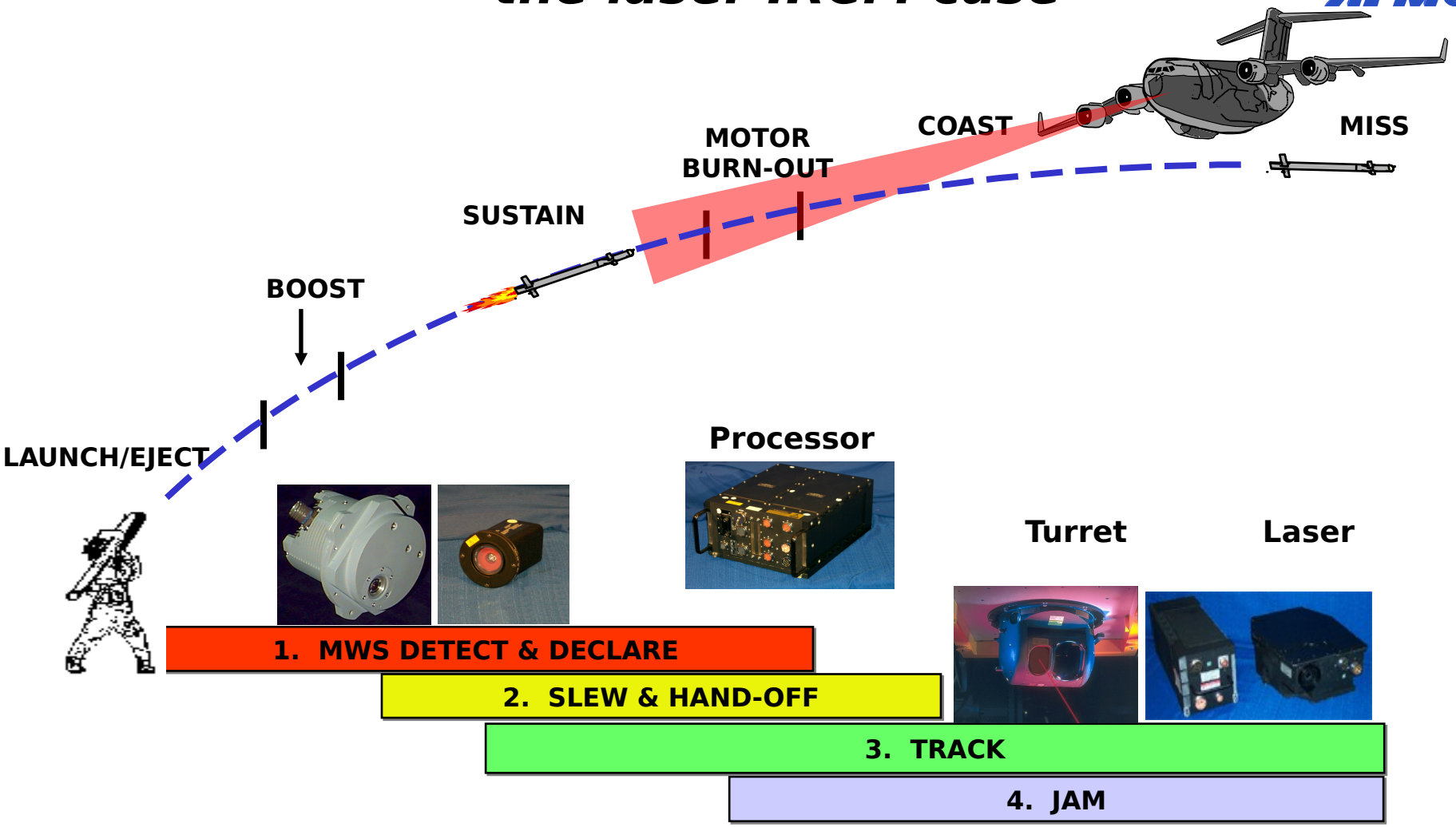
Atmospheric Effects

Aircraft Performance

Aerodynamics
Maneuvers

IRCM Effectiveness Evaluation

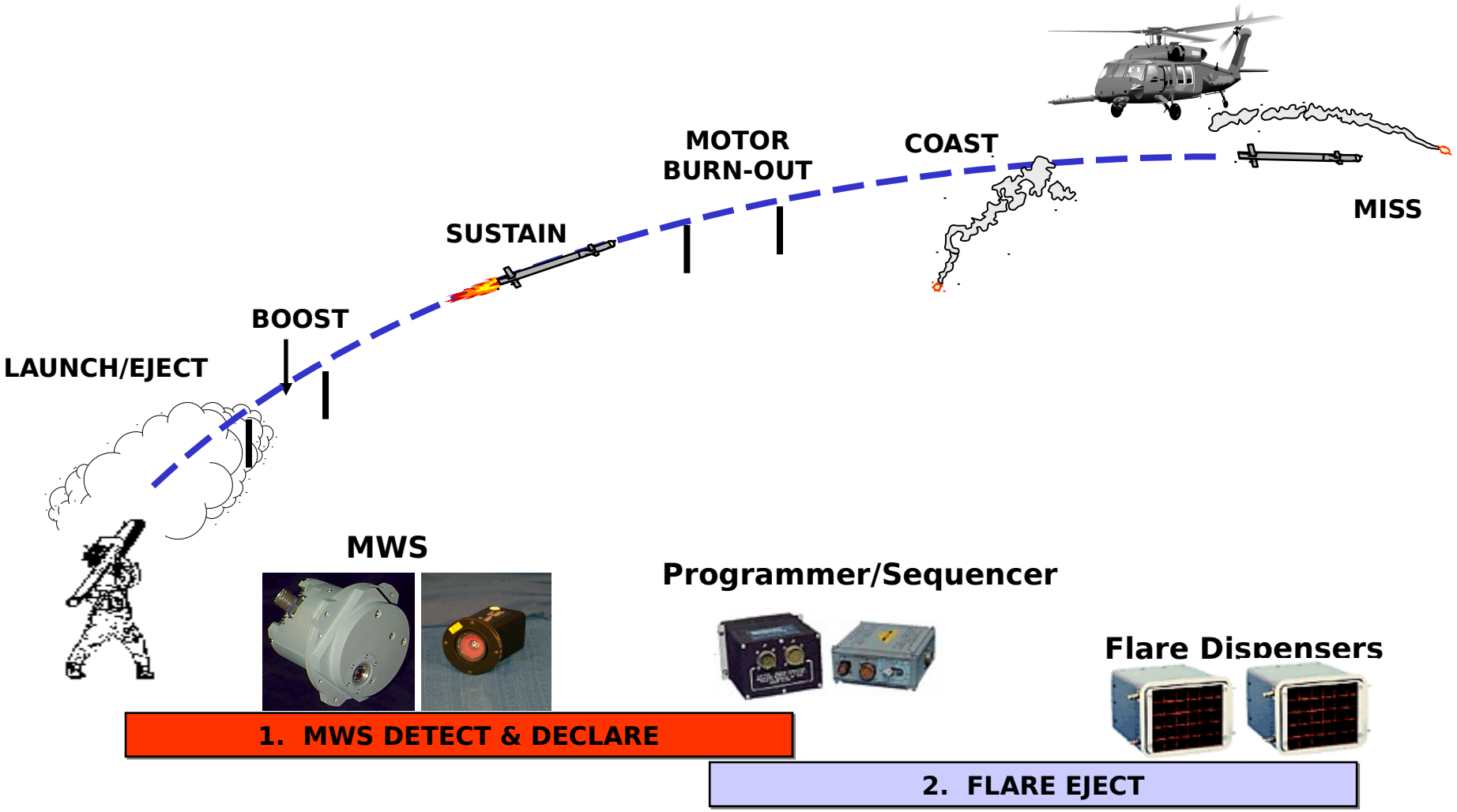
the laser IRCM case



Laser IRCM System Effectiveness $P_{miss} = P_{declare} \times P_{handoff} \times P_{track} \times$

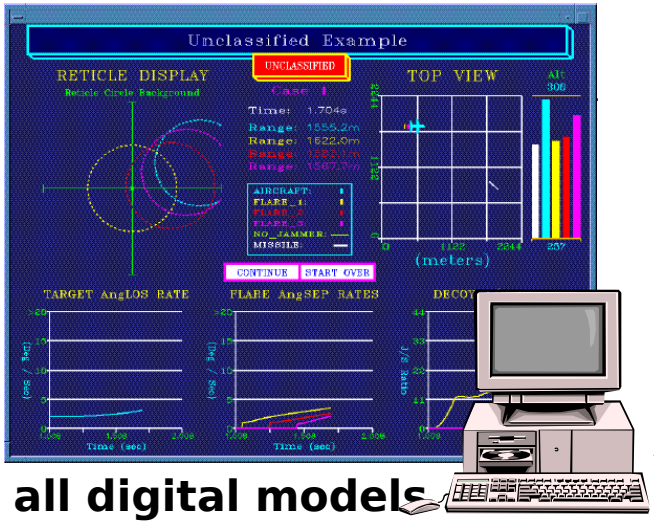
IRCM Effectiveness Evaluation

the IRCM flare case

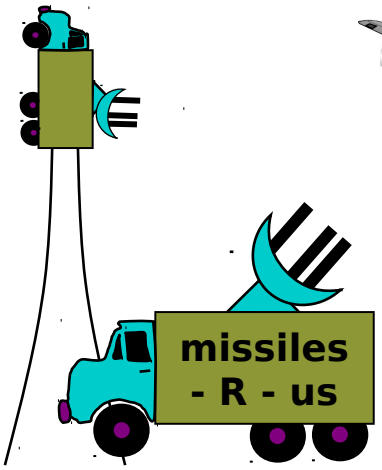


Flare IRCM System Effectiveness $P_{miss} = P_{declare} \times P_{flare} \times P$

Tools for IRCM Effectiveness Evaluation

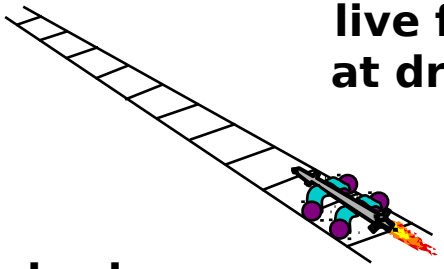


all digital models



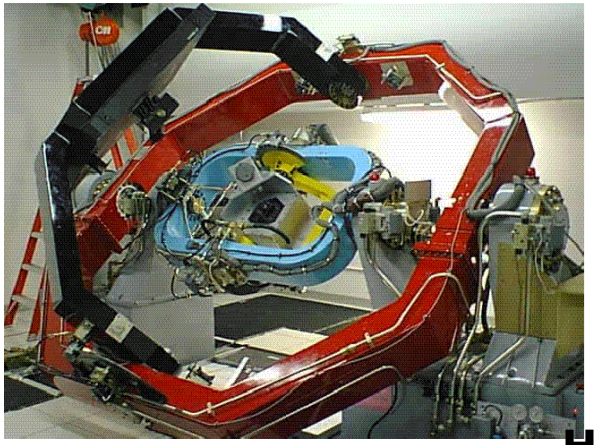
STV

instrumented grip stock

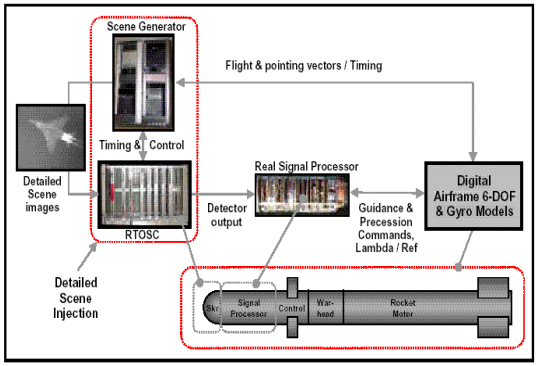


sled track

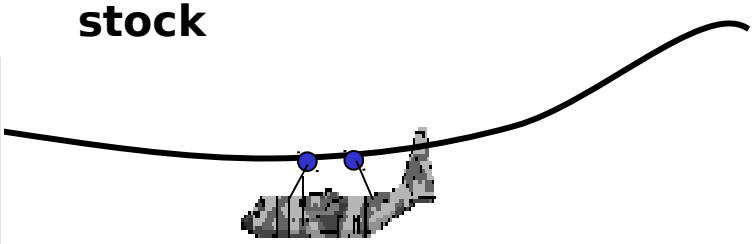
live fire at drone



HITL with seeker optics and kinematics



HITL without seeker optics



SIL

live fire cable car

Tools for IRCM Effectiveness Evaluation

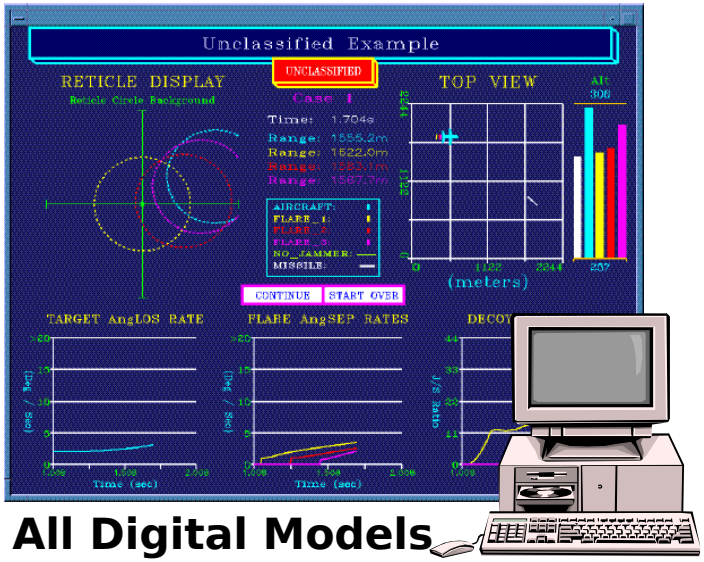
- **Each tool has fundamental strengths and limitations**

- **One must understand what one hopes to LEARN from test, evaluation, and analysis BEFORE choosing the tool**

- **Must not decide on a TOOL, THEN determine what is to be learned or evaluated**

- **Verification and validation of the tool for the specific application is critical**

Tools: All Digital Model



All Digital Models

ALL-DIGITAL MODELS:

- Emulative
  - DISAMS-based
    - GTSIMS
    - MOSAIC
- Dynamic
  - JTEAM

UTILITY:

- First step in test process
- Deterministic
- Based on many approximations

STRENGTHS:

- Very low cost per engagement
- All engagement geometries available
- Effective for dry and simple decoy evaluations

LIMITATIONS:

- Deterministic
- Based on many approximations
- Typically non-real time
- No seeker gyro/optics and missile body/seeker coupling

Tools: Instrumented Gripstock

Instrumented Gripstock

INSTRUMENTED GRIPSTOCK:

- MSIC
- SHORAD
- FT BLISS
- Others?

UTILITY:

- Notional Acquisition Range
- Launch Opportunity
- Preemptive CM
- Limited flare effectiveness assessment

STRENGTHS:

- Hardware based acquisition
- Qualitative assessment of threat acquisition performance against real target aircraft embedded in actual clutter

LIMITATIONS:

- No Flyout
- No Endgame
- Not available for many threats
- Limited engagements

Tools: Seeker Test Van

Seeker Test Van

SEEKER TEST VAN:

46 Test Wing, Eglin
MSIC
NAWC, China Lake
WSMR
Others

UTILITY:

Acquisition range determination
Preemptive Countermeasures
Optical Breaklock
Flare Decoy Insight
Clutter effects on acquisition

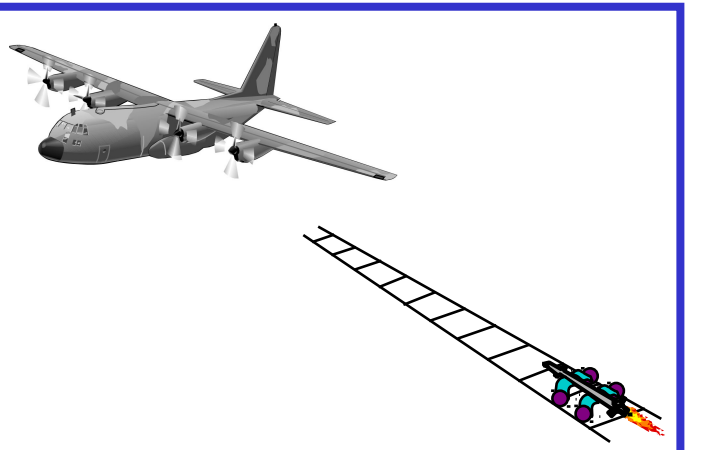
STRENGTHS:

Hardware based acquisition
Actual Target Signature
Installed IRCM System
Actual Atmospheric Path*

LIMITATIONS:

Limited Engagement Scenarios
No Missile Flyout
*Atmospherics Range/Day Limited
No Endgame Determination
Incorrect Radiant Intensity Change

Tools: Sled Track



SLED TRACK:

46 Test Wing (Holloman AFB)
China Lake (SNORT range)

UTILITY:

Installed System Declare, Handoff,
Point-Track, Jam (energy only)
System functional demonstration

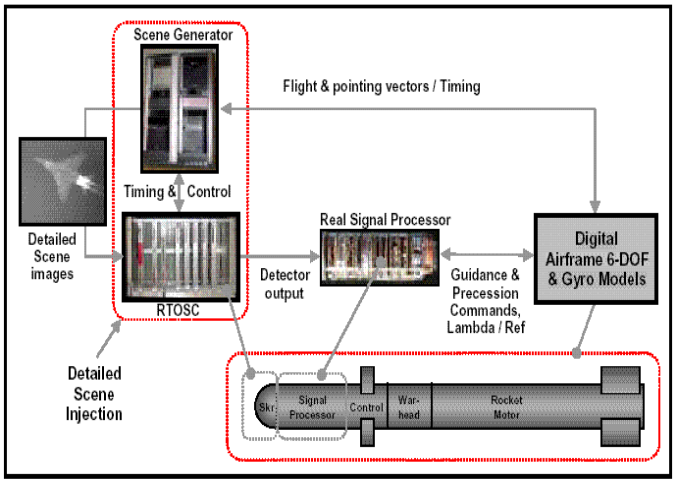
STRENGTHS:

Actual Target Signature
Installed IRCM and MWS System
Actual Atmospheric Effects*
Makes all the pieces work together

LIMITATIONS:

~~Very Limited Engagement~~ Scenario
Constrained Missile Trajectory
*Atmospherics Range/Day Limited
Low velocity missile
Distorts IR/UV missile signature
Overestimates MWS performance

Tools: HITL without Seeker Optics



HITL without seeker optics

HITL WITHOUT SEEKER OPTICS:

- MSIC Track Loop Simulators
- AFRL DIME LAB Hybrid
- NAWC T-SPIL
- BAe JamLab

UTILITY:

- Signal processing evaluation
- CM development in simplified seeker environment

STRENGTHS:

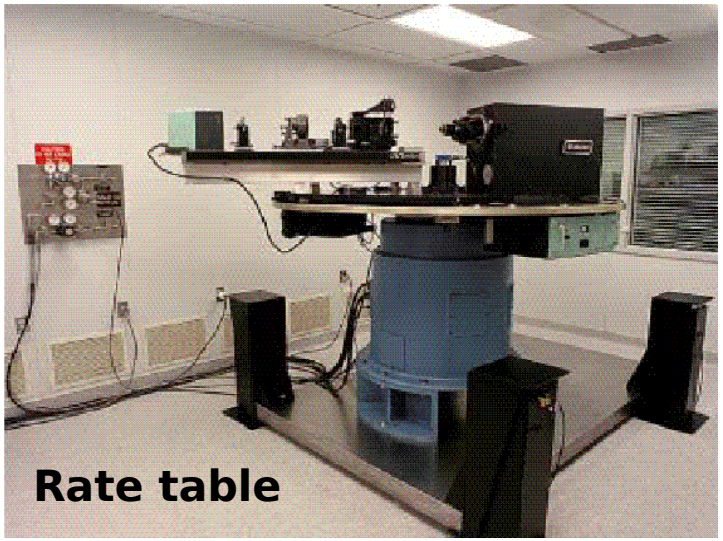
- High run productivity
- Low per shot cost
- All engagement geometries available
- Actual seeker electronics

LIMITATIONS:

- No seeker optics / reticle / gyro
- No seeker / body coupling
- Highly dependent on modeled optics and scene

Tools: HITL with Optics

rate table



Rate table

HITL WITH OPTICS – RATE TABLE:

NRL
MSIC
BAe JamLab

UTILITY:

Simple track loop evaluations

STRENGTHS:

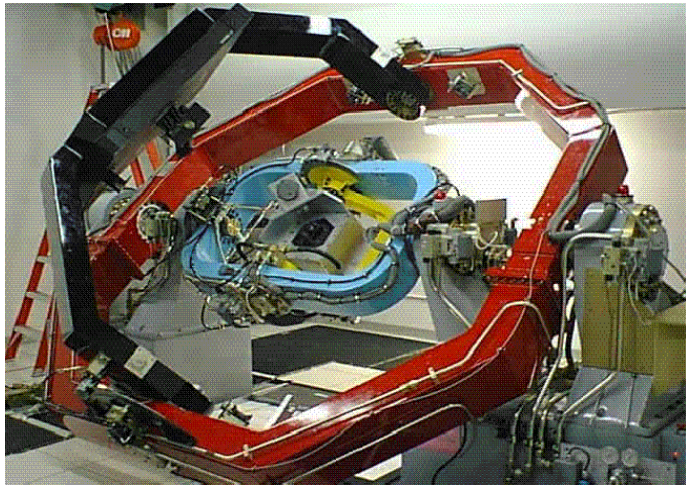
Straight-forward look at some seeker signals

LIMITATIONS:

Cannot represent 6-DOF missiles
Incorrect kinematics
Single dimension rates for rolling airframe missiles are inappropriate to determine CM effectiveness

Tools: HITL with Optics

flight motion simulator – direct projection



FMS – direct project

HITL with Optics - *direct projection*

China Lake
GWEF
BAe jam lab

UTILITY:

CM development
CM evaluation

STRENGTHS:

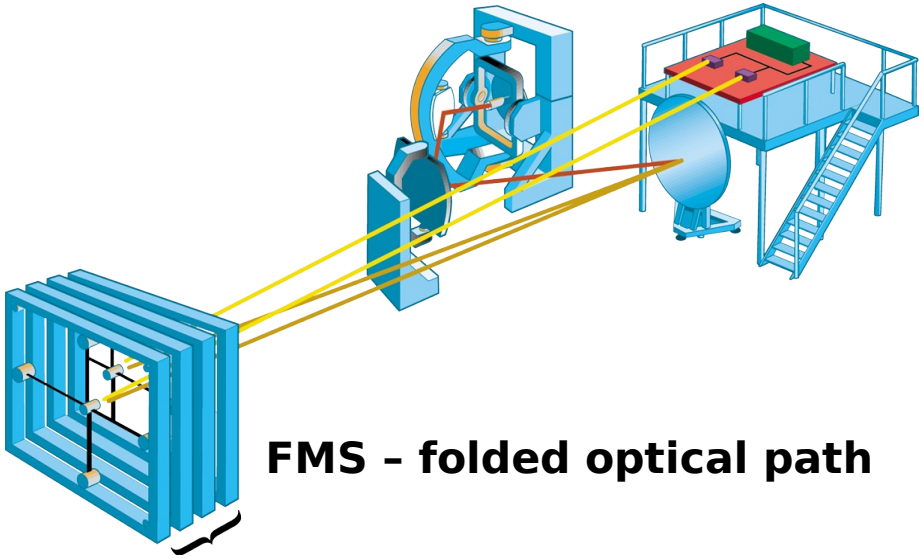
Real seeker / optics / gyro / reticle w/rolling airframe (coupling)
Actual seeker electronics
LASER CM, extended source targets / flares possible*
All engagement geometry available
High statistical confidence

LIMITATIONS:

*Depending on the source type, limited intensity / dynamic range
May have limited flare trajectories
Limited run times dictated by missile H/W
Requires careful test planning
Moderately expensive per run

Tools: HITL with Optics

flight motion simulator – folded optical path



FMS – folded optical path

HITL with Optics – *folded optical path* AFEWES

UTILITY:

CM waveform development
CM effectiveness evaluation

STRENGTHS:

Real seeker / optics / gyro / reticle w/rolling airframe (coupling)
Actual seeker electronics
Actual laser hardware / jamcode
Distributed engines for large aircraft
All engagement geometry available
Correct point-source flare

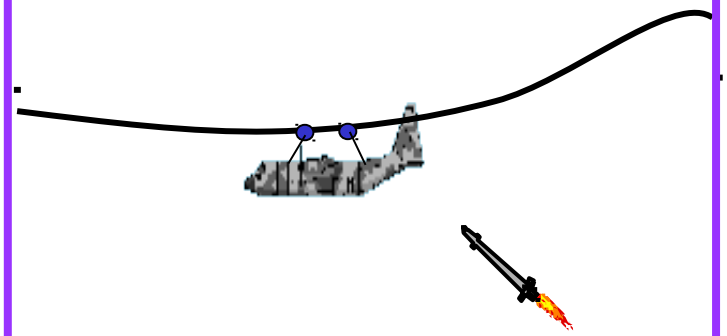
LIMITATIONS:

Depending on source – cannot do extended source CM / target
Limited run times dictated by missile H/W
Requires careful test planning
Moderately expensive per run

Tools: Live Missile Firing - ACR

Live Missile Firing - ACR
WSMR

UTILITY:
System-level evaluation of IRCM



Live Missile Fire
Aerial Cable Range

STRENGTHS:
- Live fire missile
- Actual MWS and IRCM equipment
- Actual atmospherics*
- Real flare eject velocity
- Actual installed laser IRCM system
- Actual flares and eject velocity**
- Actual engagement timeline***

LIMITATIONS:
- Per missile shot cost is very high
- Limited engagements
- Aircraft signature are incorrect
- *Atmospherics Range/Day Limited
- Line-of-sight rates limited
- **Flare trajectories limited
- Low IR clutter & low UV attenuation

Tools: Live Missile Firing - Drone

Live Missile Firing - ACR

WSMR
Eglin
China Lake

UTILITY:

Installed system evaluation of CM

Live Missile Fire Drone

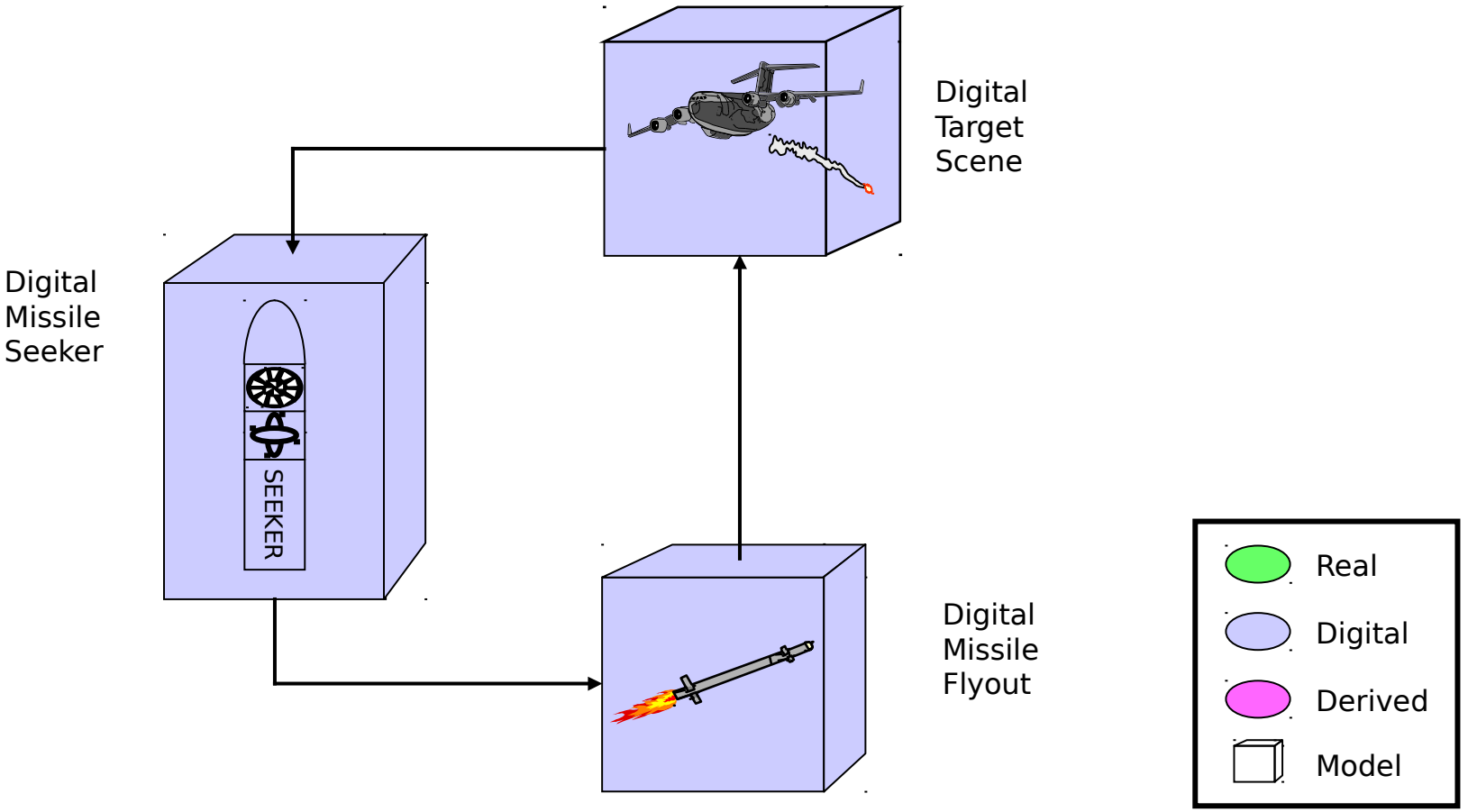
STRENGTHS:

Fully installed system equipment
True flight characteristics of target
Live fire missile
True target signature*
Actual atmospherics**
Accurate flare trajectories
Actual installed laser IRCM system
Actual flares and trajectories

LIMITATIONS:

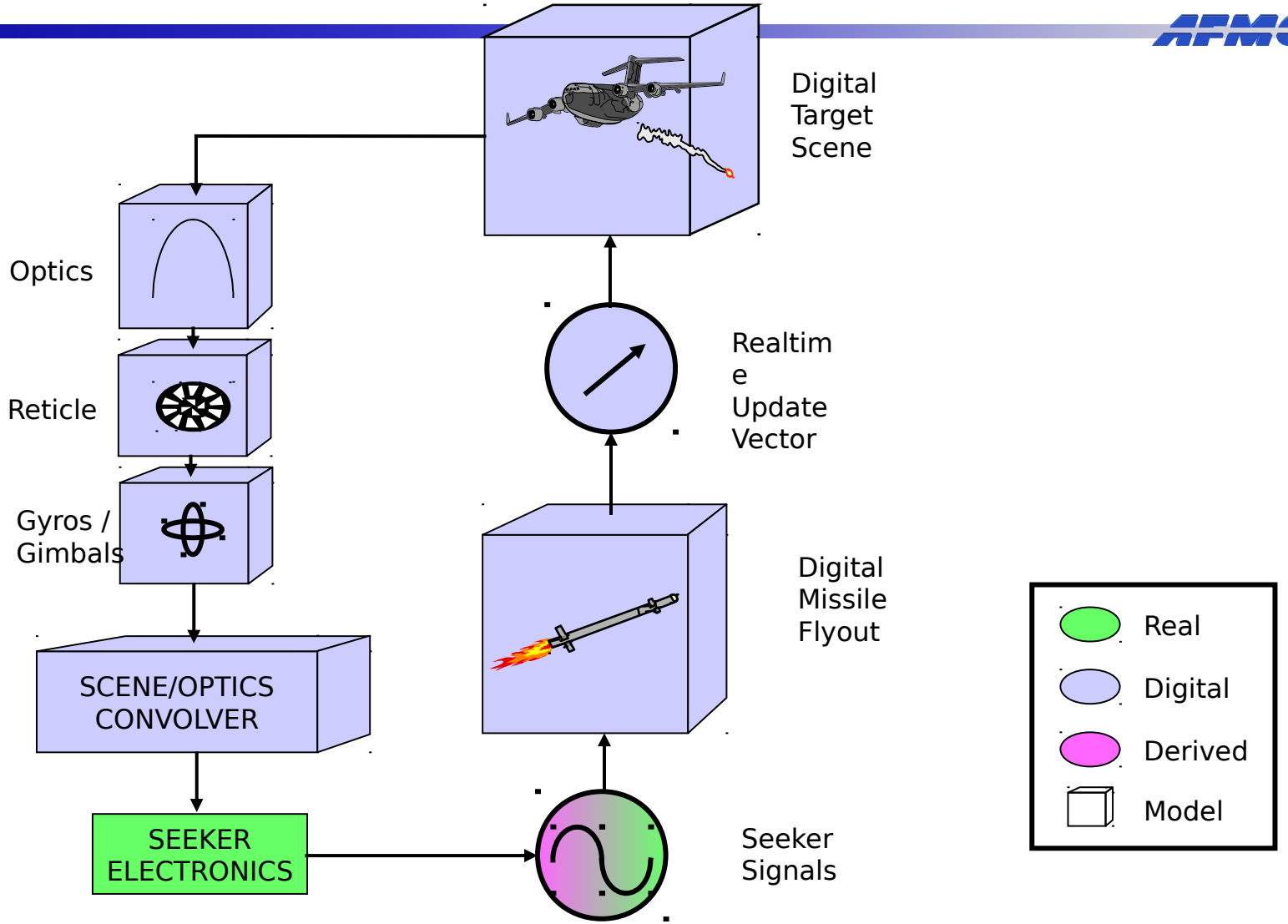
Per missile shot cost is very high
May not be available
Limited engagements (not as restrictive as ACR)
*Aircraft signature may be incorrect
**Atmospherics Range/Day Limited
***Optimistic detect times

Block Diagrams
All Digital Simulations



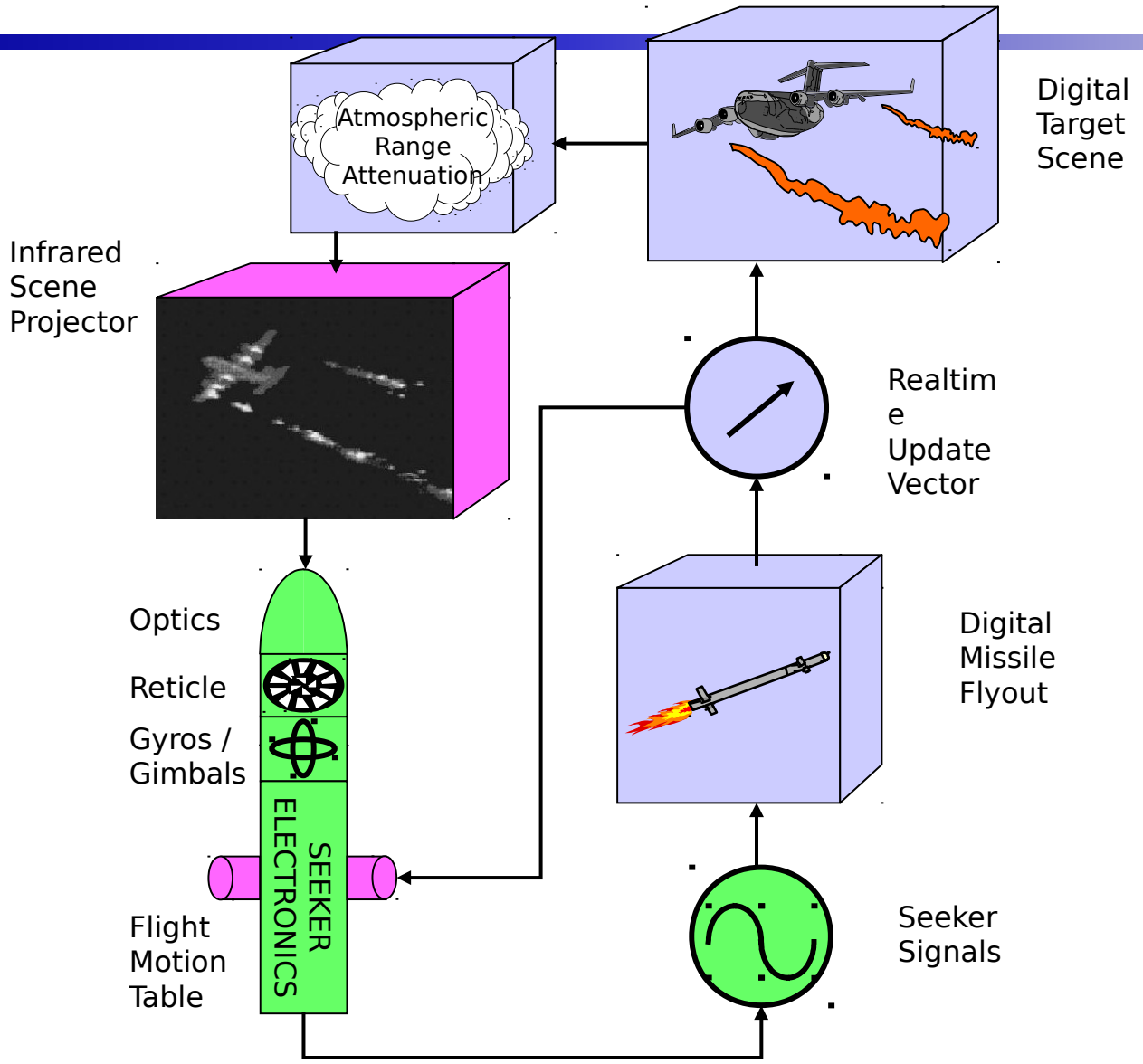
Block Diagrams

Hybrid Track Loop Simulator



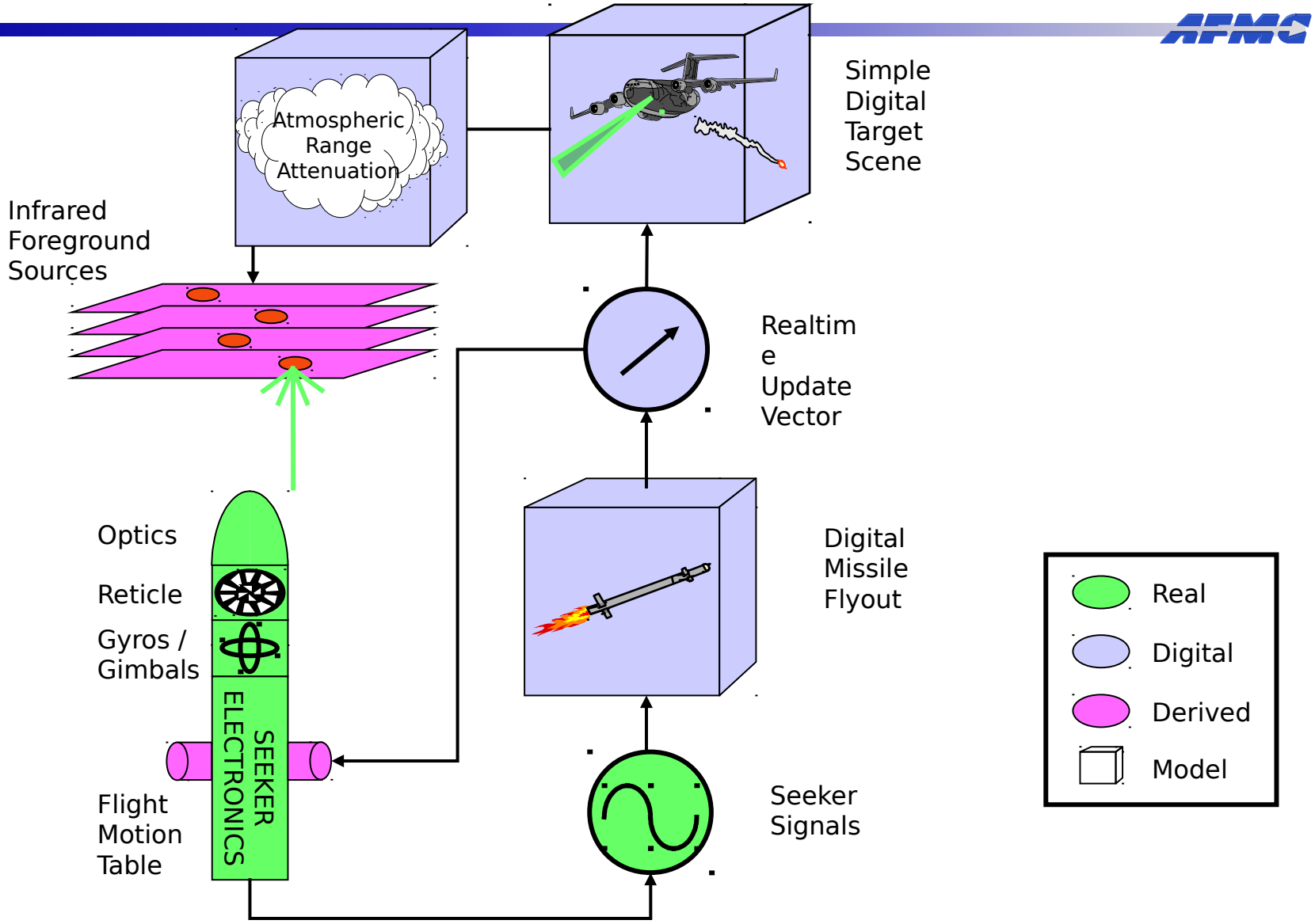
Block Diagrams

Direct Projection HITL

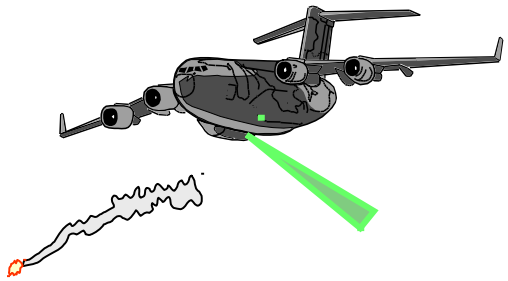


Block Diagrams

Folded Optical Path HITL



Block Diagrams
Seeker Test Van



Actual
Target
Scene

Real
Digital
Derived
Model

Open Loop

Optics
Reticle
Gyros /
Gimbals
Trackin
g
Mount
SEEKER ELECTRONICS
Seeker
Signals

Choosing the Right Tools

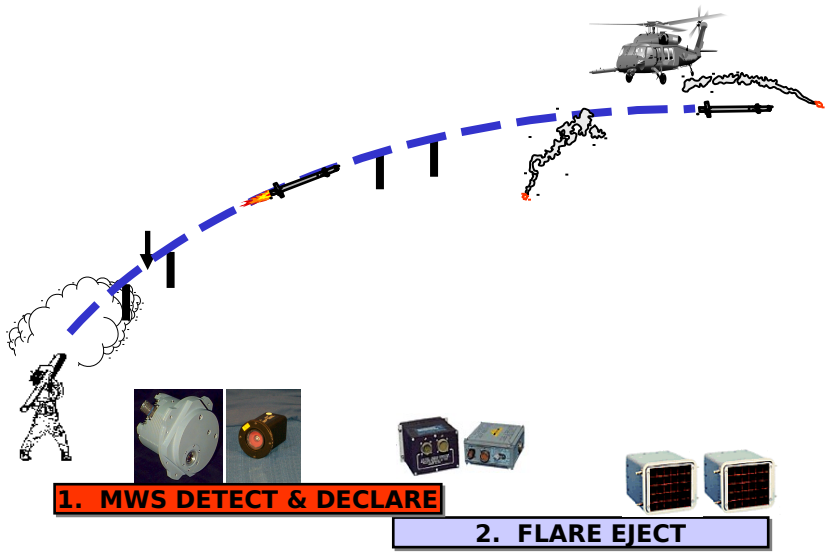
the premises revisited

- No one tool can do it all
- Know what you want to learn
- Understand tool strengths and limitations
- Assess fidelity requirements
- Verify, Validate, Accredit

Fidelity: The Question

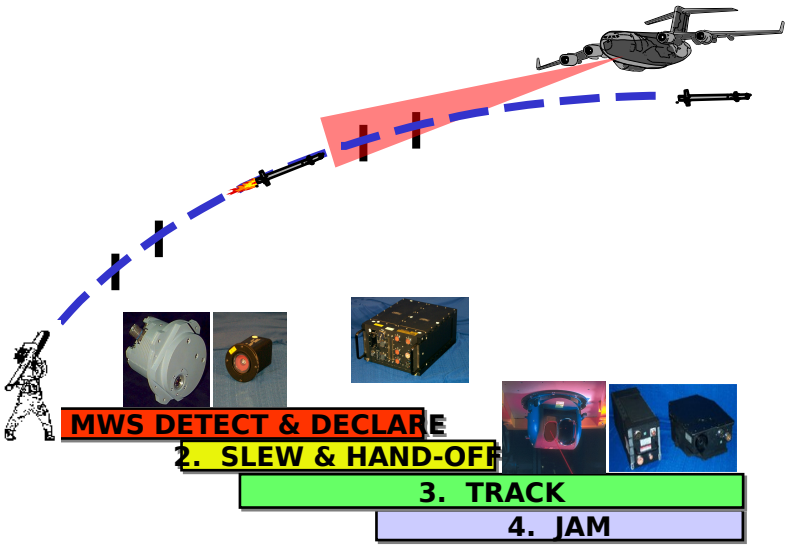
how good is good enough?

AFMC



A DECOY solution MAY require higher levels of scene fidelity

An OPTICAL BREAK LOCK solution MAY require lower levels of scene fidelity – higher fidelity in seeker optics and seeker/body coupling

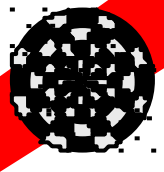


Analysis of the impact of input fidelity and input absolute accuracy on engagement outcome is REQUIRED to enable credible IRCM effectiveness assessment

Fidelity: The Evolving IR Threat

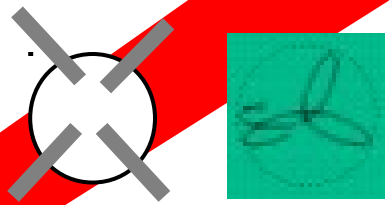
how good is good enough?

AFMC



1960s
Spin Scan

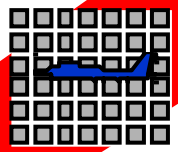
1970/80
Cooled
Con Scan



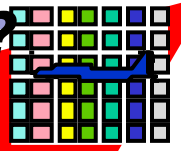
1980s/90s
Cross Array/Rosette
Flare CCMs

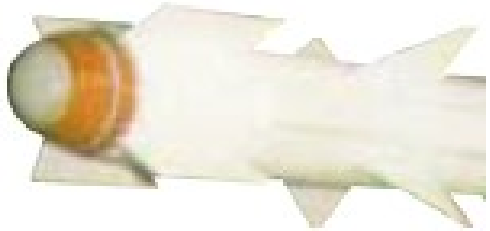
2000
Scanning
Imagers

2005
1st Generation
Imagers



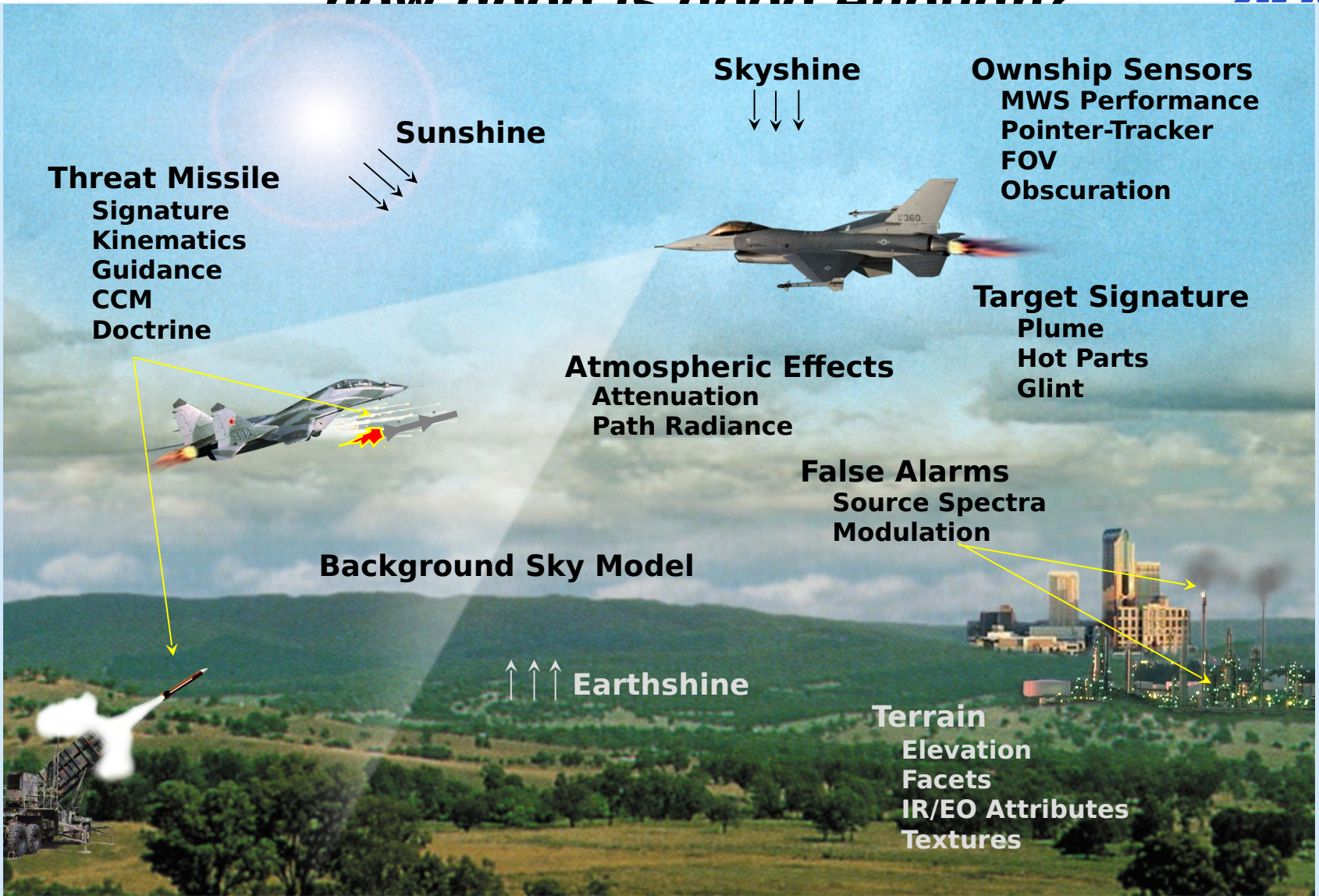
2010
2nd Generation
Spectral Imagers





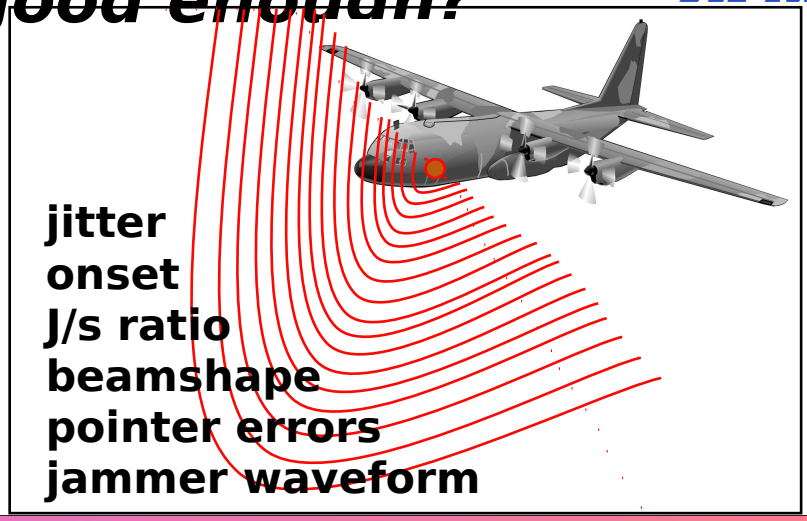
Fidelity: The IRCM World Picture

how good is good enough?

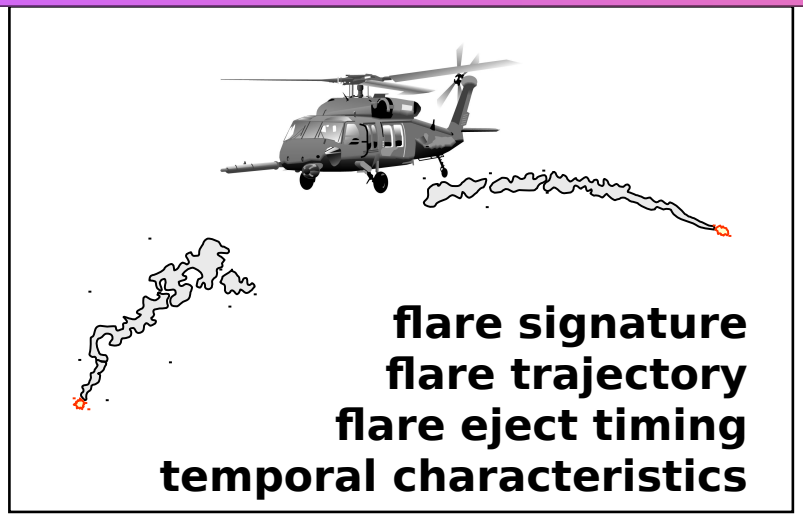


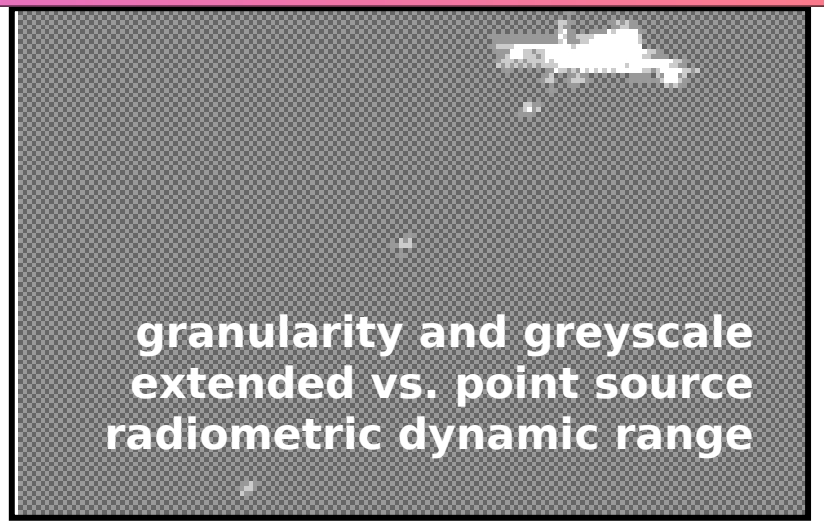
Fidelity: The Target/IRCM Scene

how good is good enough?



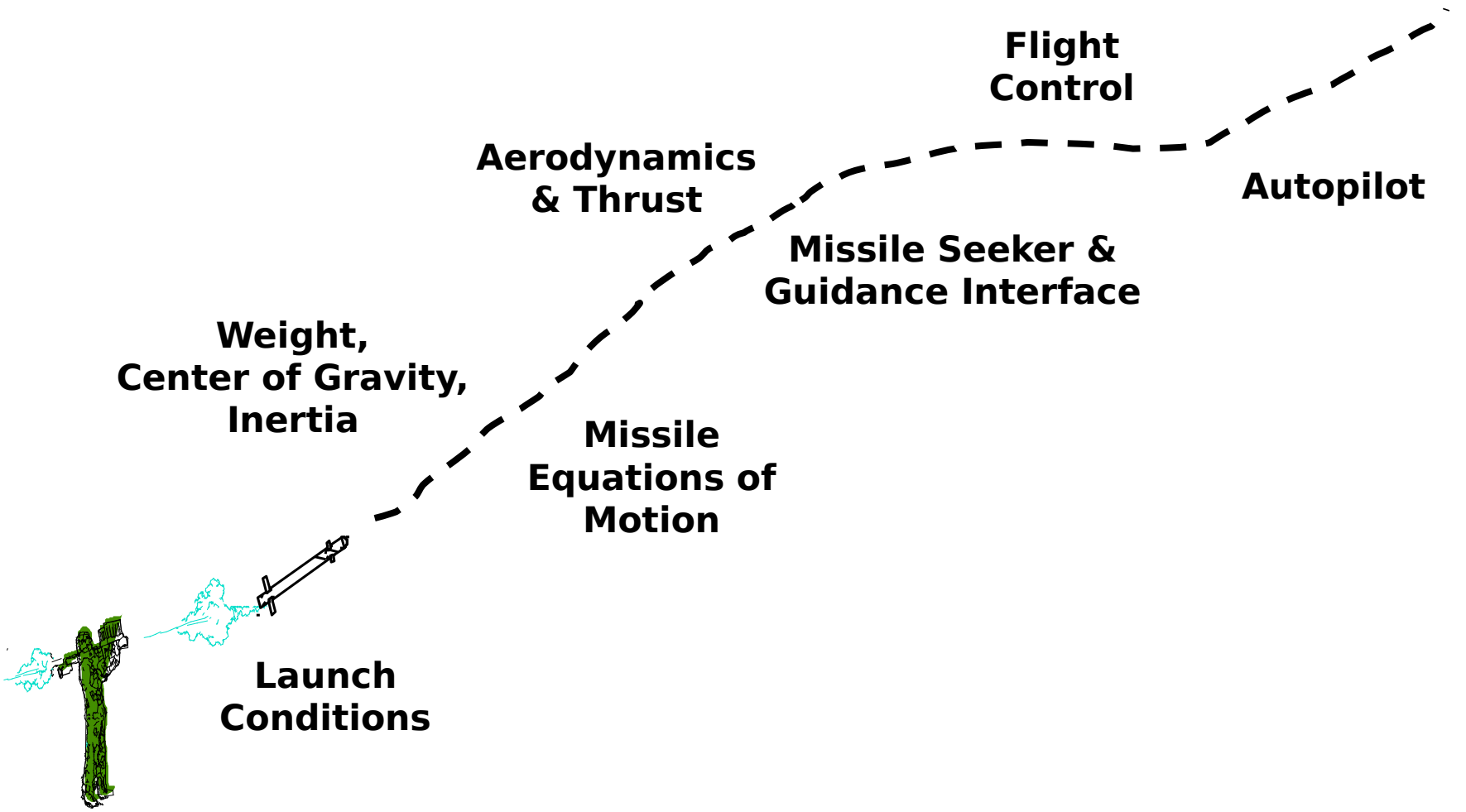
mospherics affect how all IR pieces arrive at the seek





Fidelity: Missile Flyout

how good is good enough?



V V & A

key to credibility

Verification: Determines the achieved accuracies of each simulation element and documents simulation performance

Validation: Determines the degree to which the simulation is an accurate representation of the real-world from the perspective of the intended use of the simulation

Accreditation: Determines whether the simulation adequately enables the required decision

Validation Tools
definitions

Benchmarking: Comparison of simulation outputs with outputs of another simulation that is accepted as a “standard”

Face Validation: Comparison of simulation design and outputs (under well defined conditions) with the expectations and opinions of subject matter experts (SMEs) in the simulation area of interest

Results Validation: Comparison of simulation outputs with the results of test measurements made under identical input conditions

Sensitivity Analysis: Determination of the variation in simulation outputs for measured changes in inputs, functional operations, or other conditions (generally used to supplement other validation methods)

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AFEWES HITL Test Process

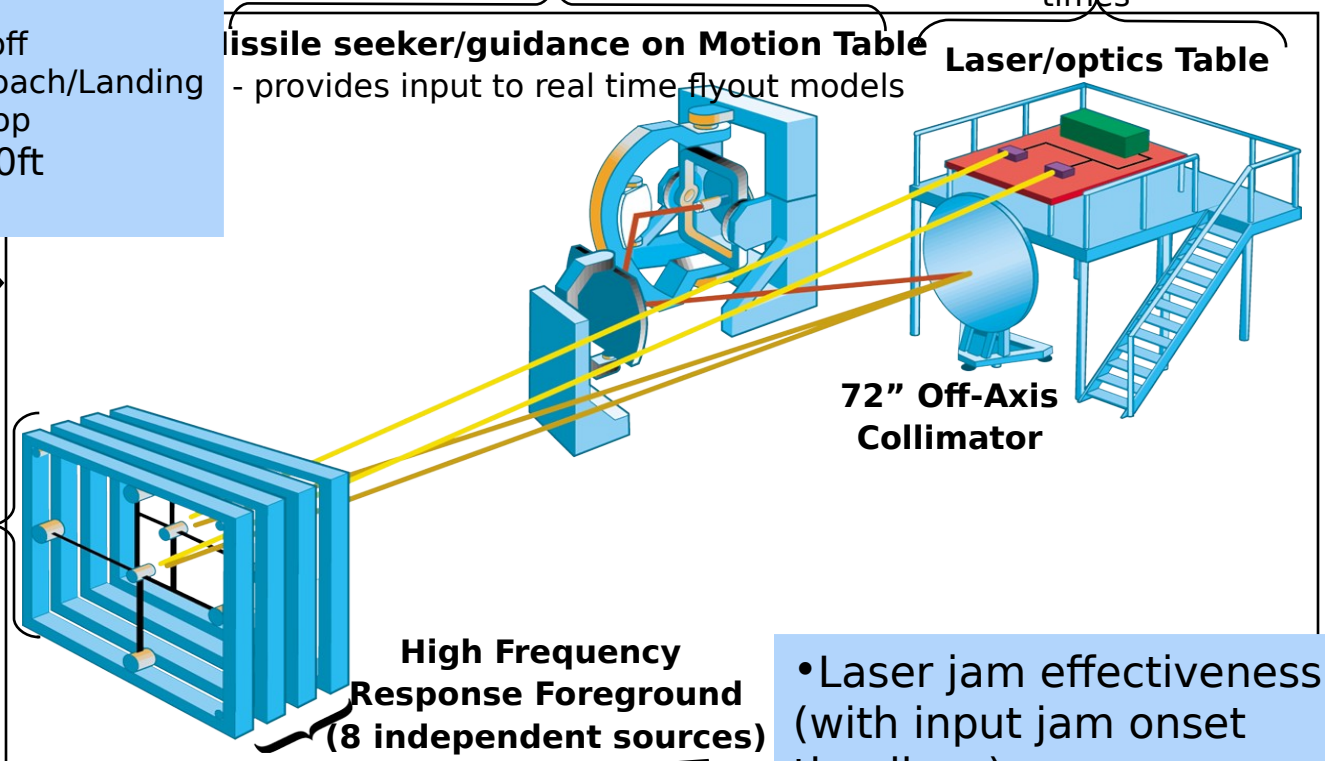
- Scenarios
  - -Profiles
    - Takeoff
    - Approach/Landing
    - Airdrop
  - All at 1000ft
  - 9 threats

C-17:
-A/C IR signature
- Engines and exhaust plume
- Landing lights

-jammer locations

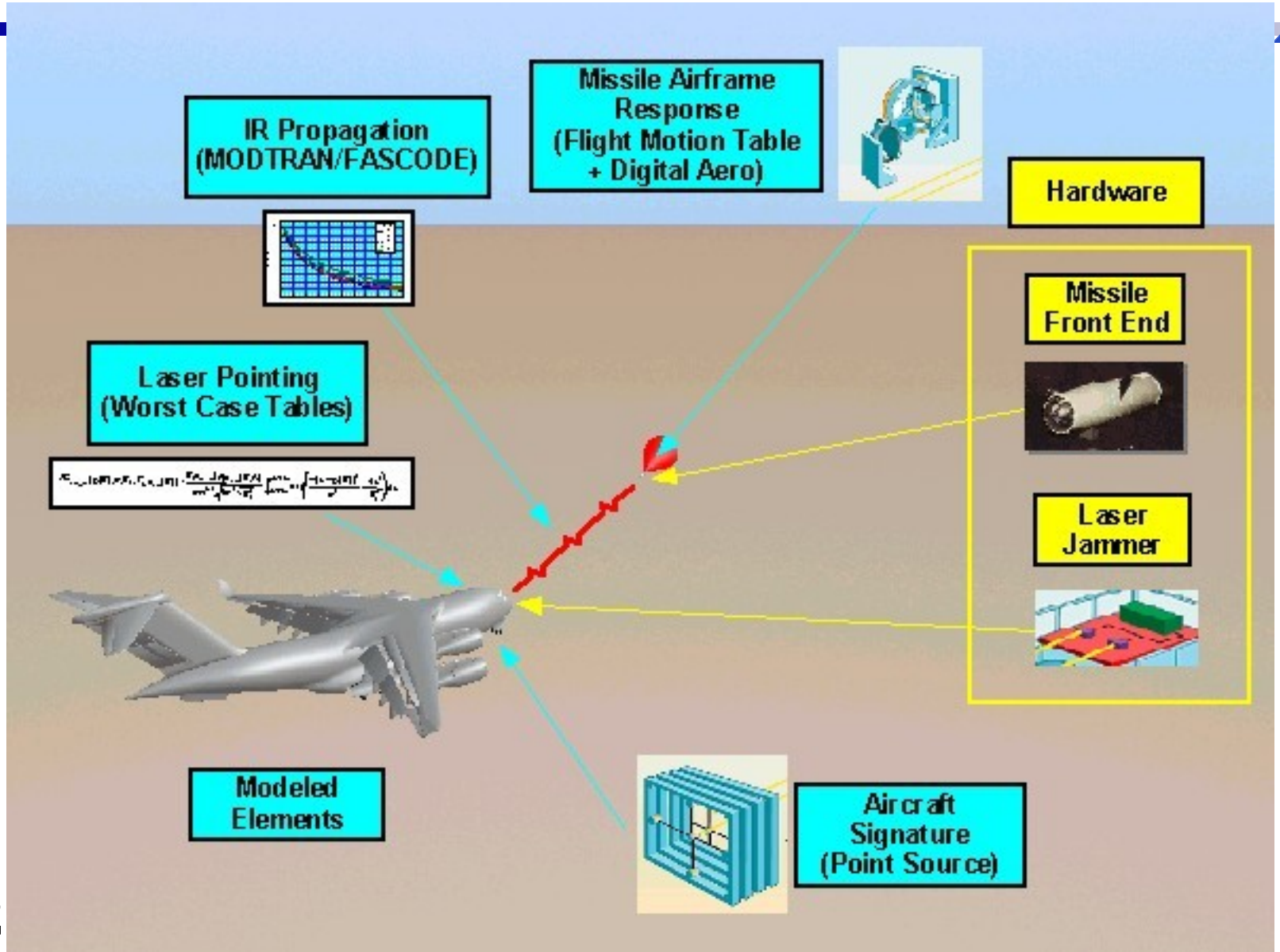
Missile in flight

Production representative laser, and laser attenuation and onset times


issile seeker/guidance on Motion Table
- provides input to real time flyout models
Laser/optics Table
72” Off-Axis Collimator
High Frequency Response Foreground (8 independent sources)

- Laser jam effectiveness (with input jam onset timelines)
- Calculate probability of miss

HITL Elements Implementations



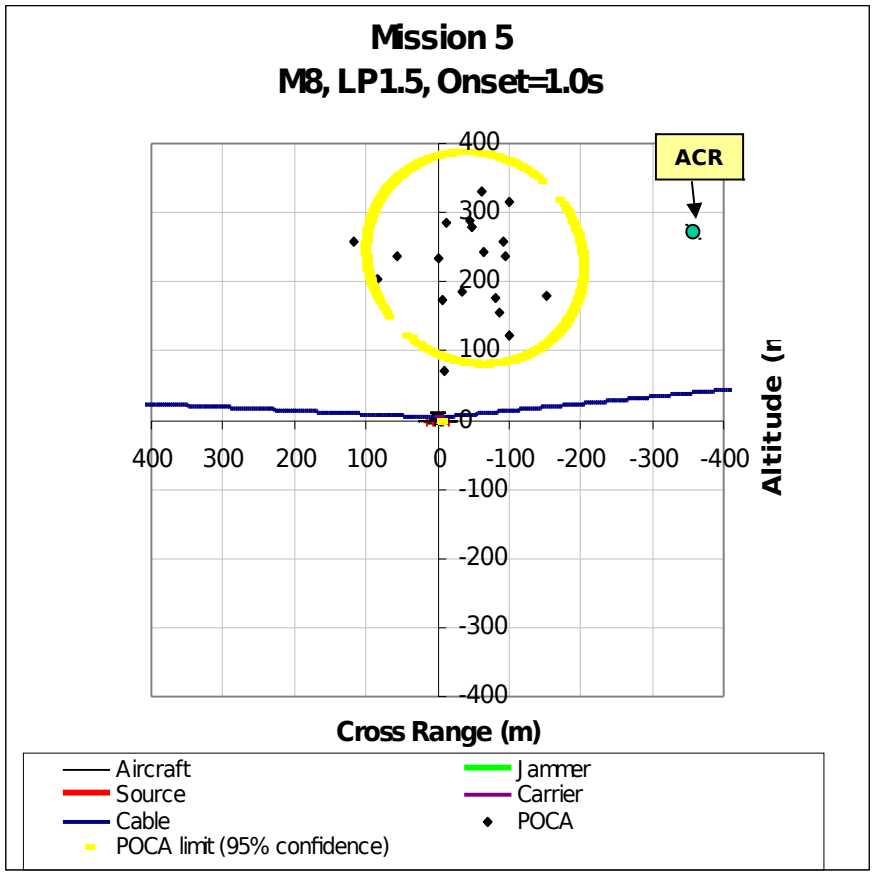
HITL vs. ACR

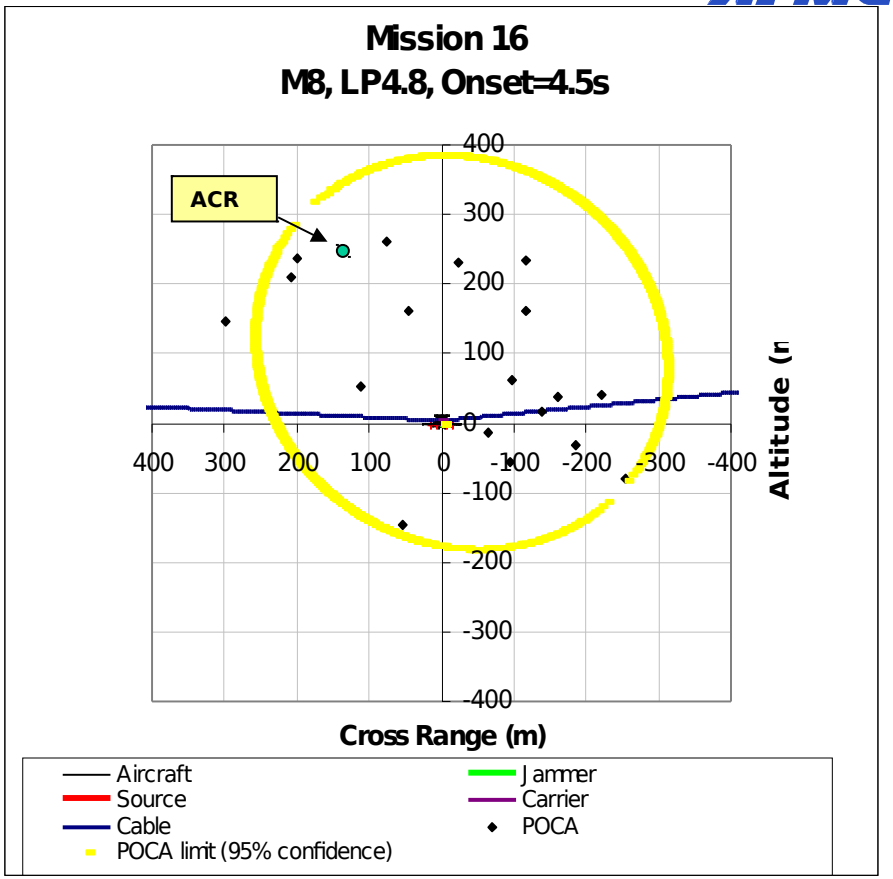
ELEMENTS	COMPONENTS	HITL	ACR
THREAT	TRAJECT		
	UV SIGNAT.		
	IR SIGNAT.		
PROPAGATION	UV		
	IR		
AIRCRAFT	FLIGHT PATH		
	IR SIGNAT.		
	STRUCT.		
MWS	SENSOR		
	DATA PROCESSING		
	ALGORITHM		
IRCM	TURRET		
	FTS		
	LASER		
BACKGROUND	UV		
	IR		

- ACR provides the closest physical means of testing
- Components are actual elements
- HITL has significant hardware implementation

CODE	Characterization
	Actual
	Actual Limited
	Hardware Imple.
	Digital
	Not Represented

Initial Comparisons of ACR and HITL



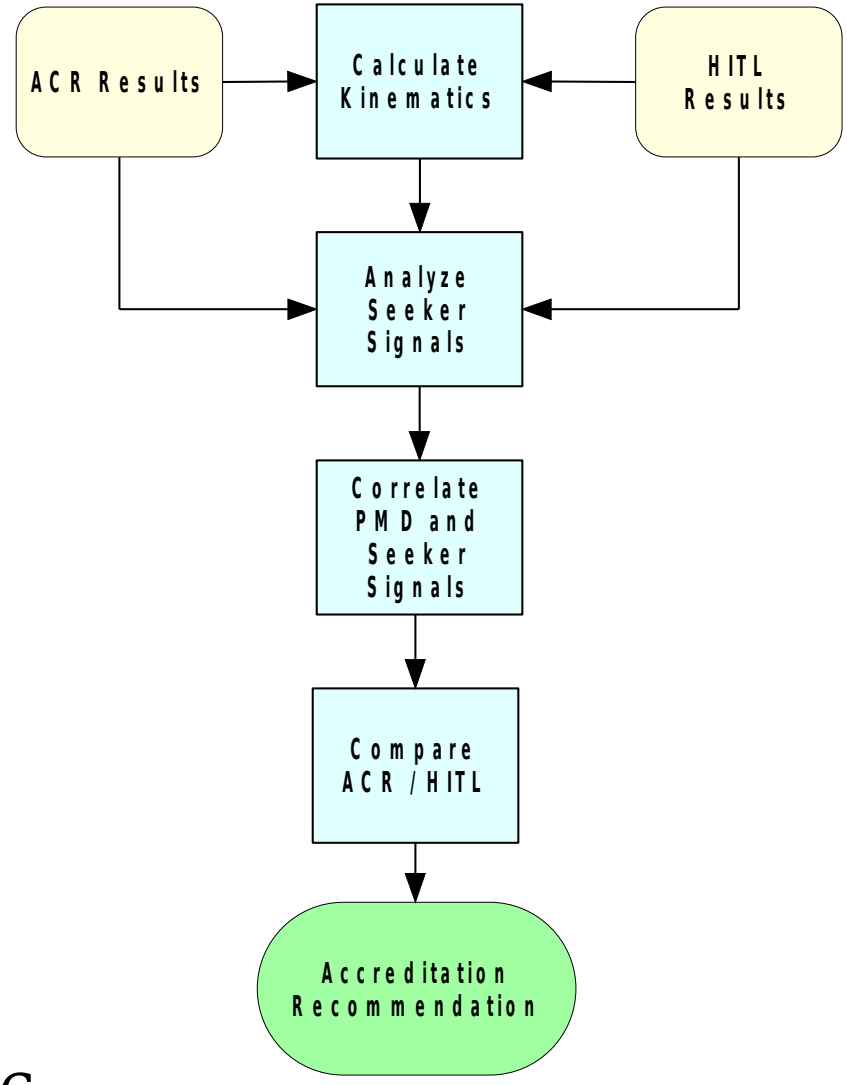


Yellow boundary is 95% confidence limits of HITL miss v

ACR Correlation Shots

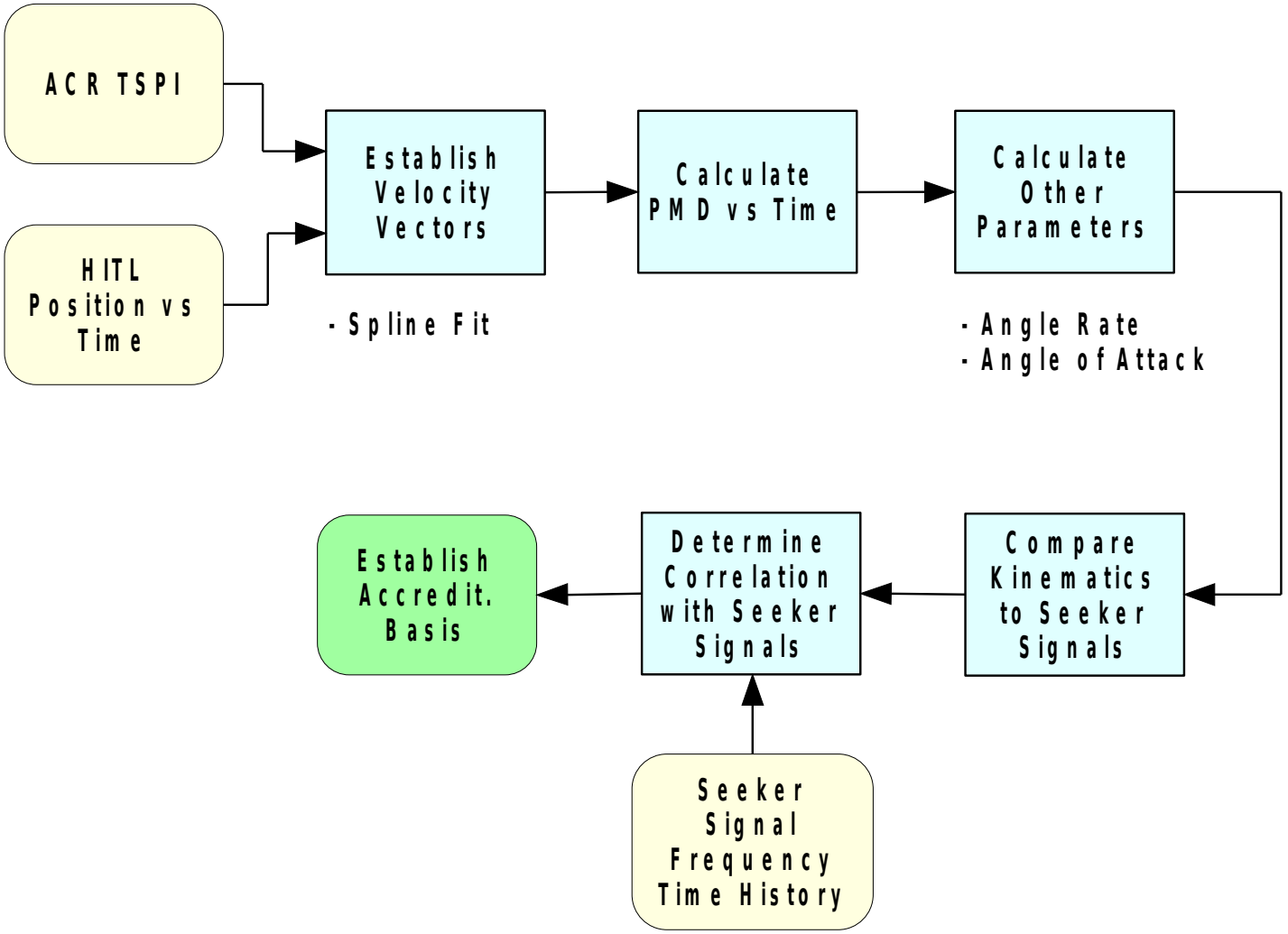
			Jam Onset					
Missile	Event No	HITL TC	HITL	DVT	ACR	TOF	MISS	Within 95%?
	8	22	1.3	1.32	1.179	4.53	296	NO
M2	24	71	3.4	3.82	3.299	6.72	227	YES
	26	131	5.2	3.51	3.84	7.52	665 (impact range)	NO
	9	31-Use 30	1.2	1.02	FAIL	3.15	9.4	N/A
M5	15	141	2.5	3.49	2.765	6.24	1557	NO
	20	141	2.5	3.99	3.206	6.23	1303	NO
M7	5	42	1.3	1.12	0.913	3.67	287	NO
	12	151	4.6	5.73	5.213	8.32	208	NO
M8	7	52	1.3	1.12	0.917	3.52	486	NO
	13	161	1.5	5.94	4.915	8.25	289	YES
	4	62	1.3	1.33	1.175	3.07	320 (impact range)	NO
	14	171	3.6	5.51	3.523	8.19	27	YES
M9	18	111-Use 110	2.8	4.35	FAIL	5.12	8.5	N/A
	27B	192	2.3	1.85	4.12	6.67	315 (impact range) 218 extrapolated	YES
	28B	182	4.3	6.83	4.202	6.79	93	YES, but smaller than HITL minimum

HITL Accreditation Methodology



- Kinematics for response to jamming calculated for ACR and HITL
- Seeker outputs for ACR and HITL are analyzed
- Correlation of PMD and seeker outputs are determined
- ACR and HITL results compared to support the accreditation recommendation

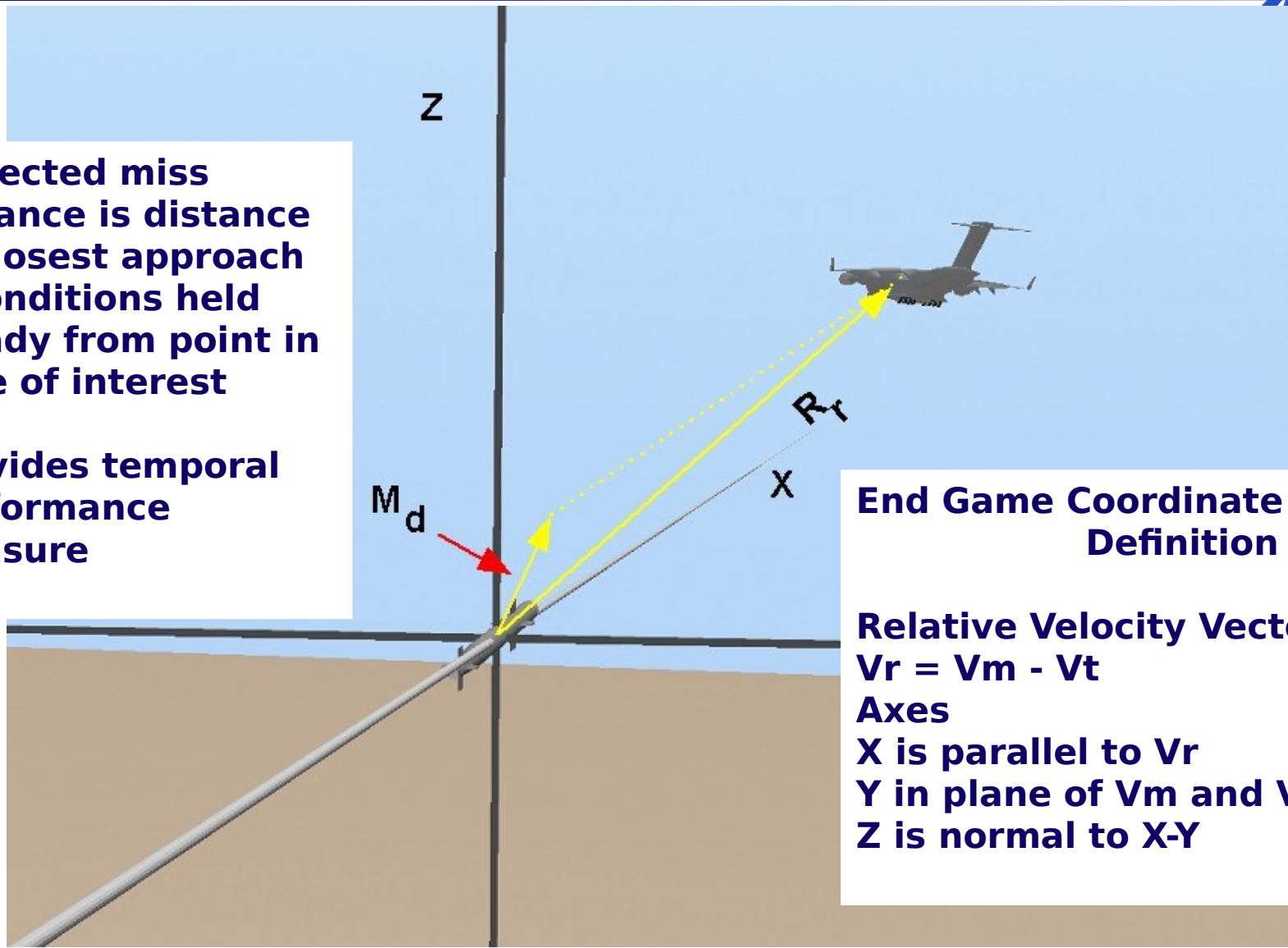
Kinematic Analysis



PROJECTED MISS DISTANCE (PMD)

Projected miss distance is distance of closest approach if conditions held steady from point in time of interest

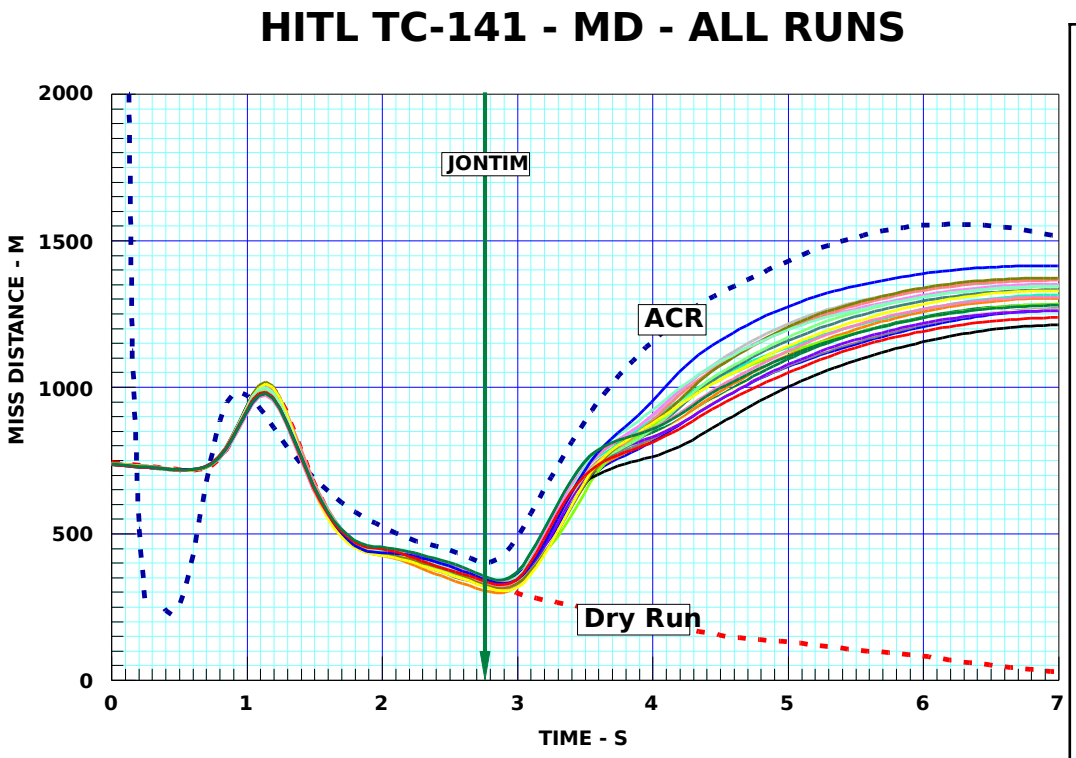
Provides temporal performance measure



End Game Coordinate System Definition

Relative Velocity Vector
Vr = Vm - Vt
Axes
X is parallel to Vr
Y in plane of Vm and Vt
Z is normal to X-Y

Example of Kinematics

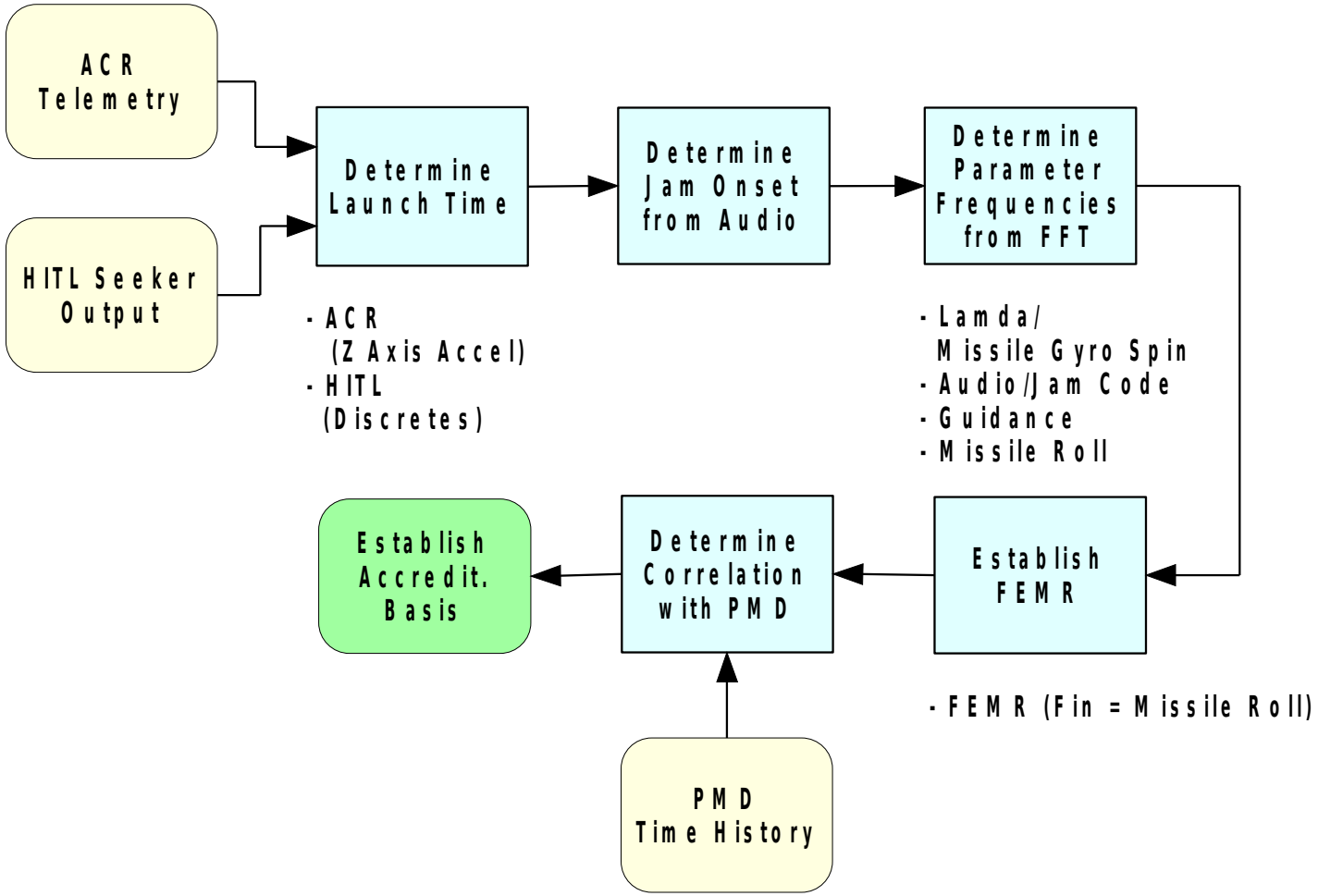


- Response to jamming (arrow) show increase in PMD*
- ACR and HITL time histories correlated well
- Kinematic behavior is the bottom line

* Fundamentals of Tactical Missiles “, Edited by R. Jeff Gurvine & Edwin G. Stauss, Missile Technical Staff, page 14-11,

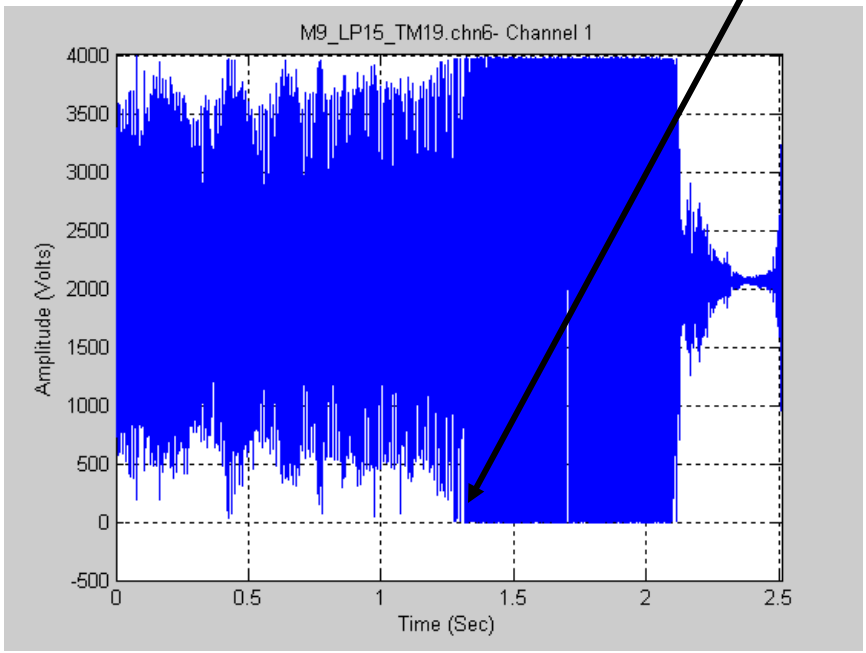
Raytheon Missile Systems Company, Tucson, AZ, 1998.

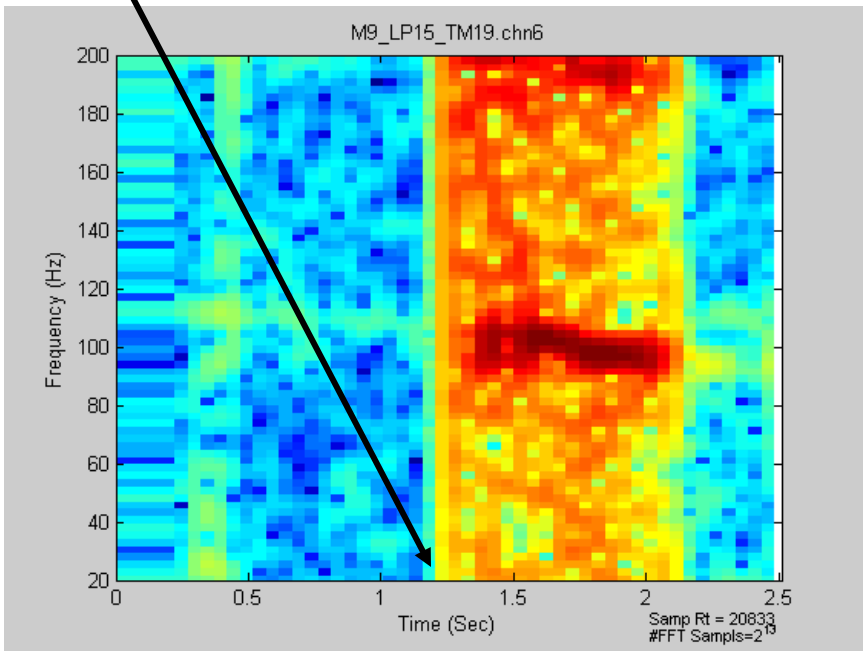
Seeker Signal Analysis Process



Determine JAM Onset Time (JONTIM)

JONTIM



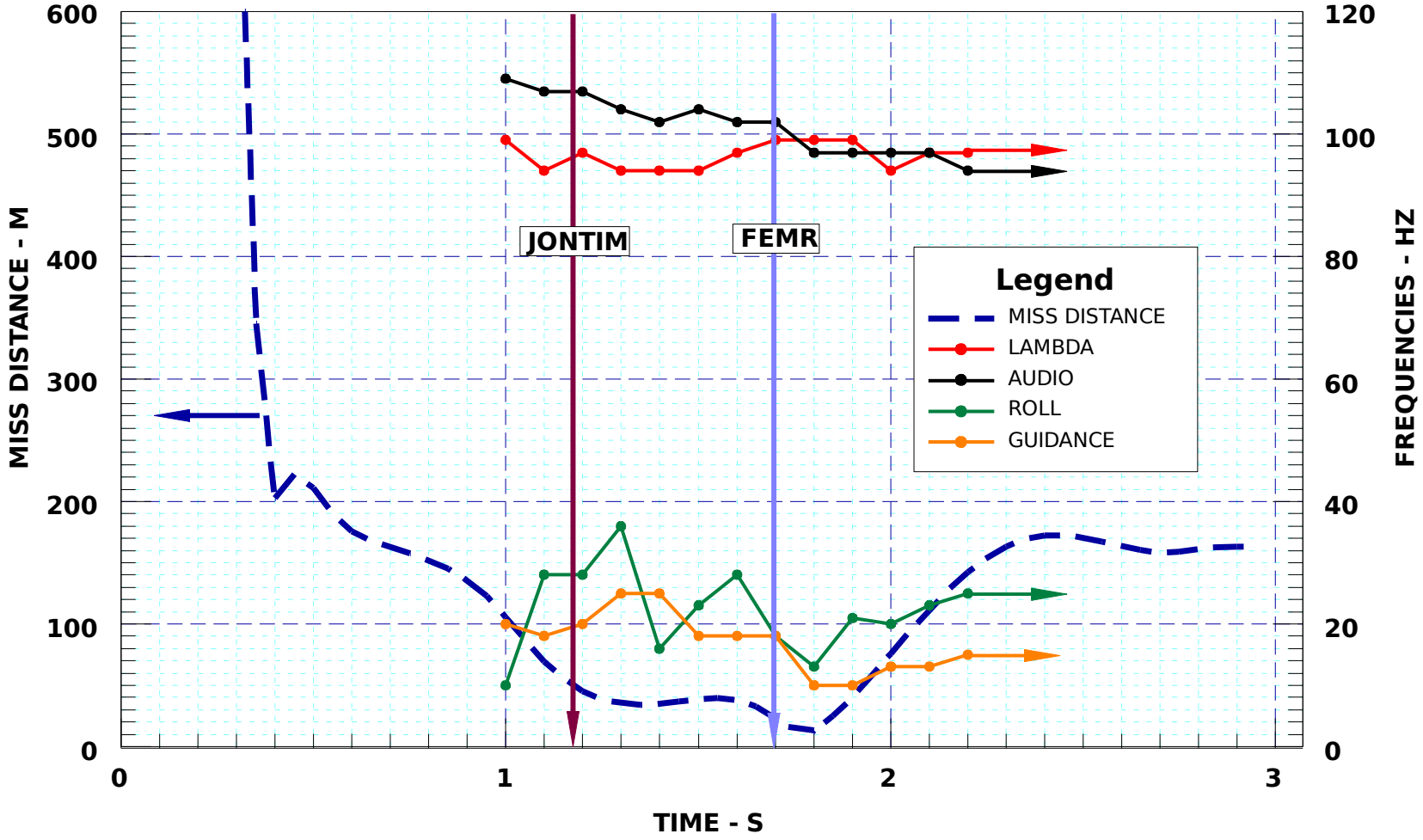


Time

Frequency

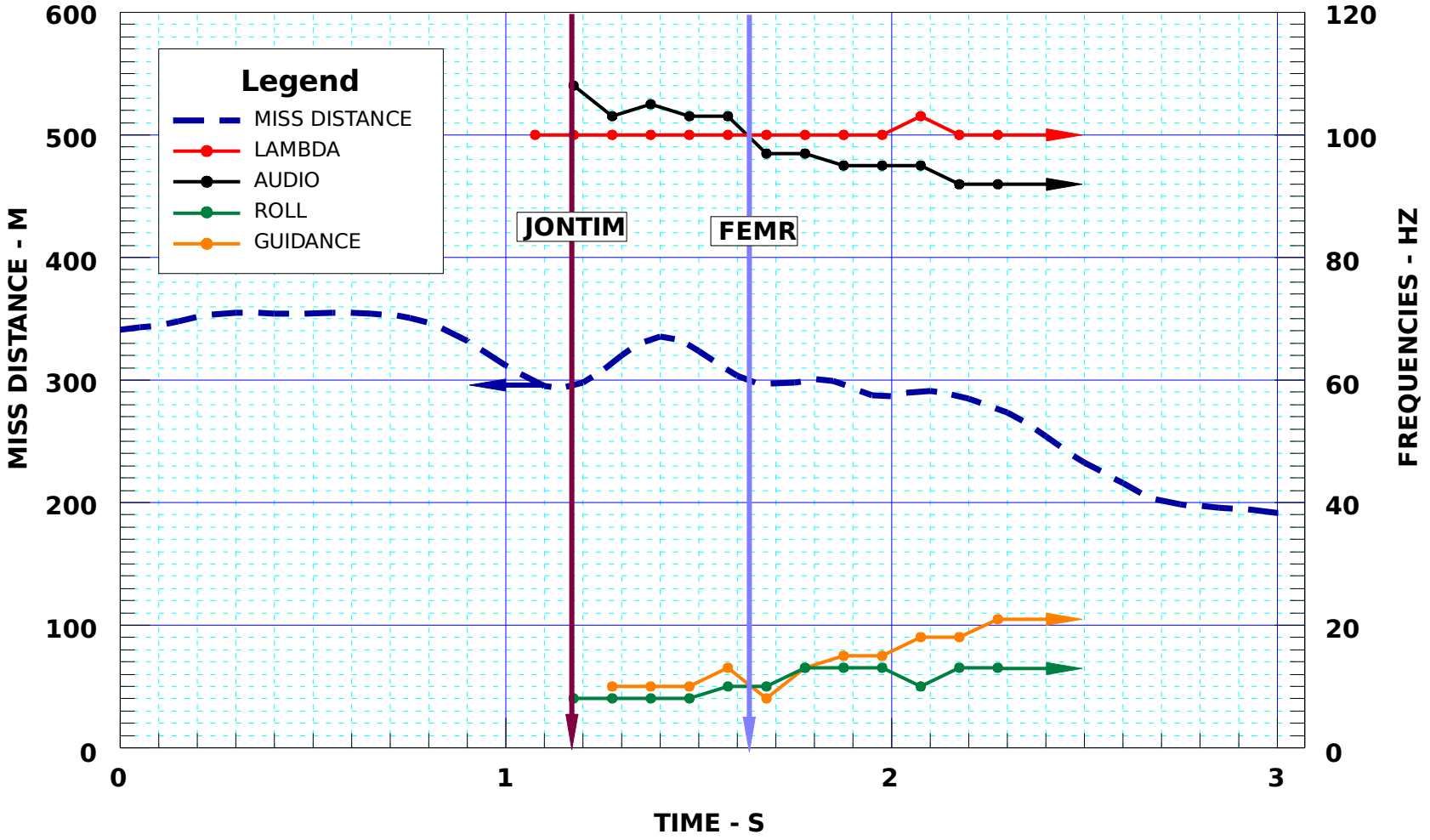
PMD vs. Seeker Signal Frequency

M9 - ACR EVENT 4

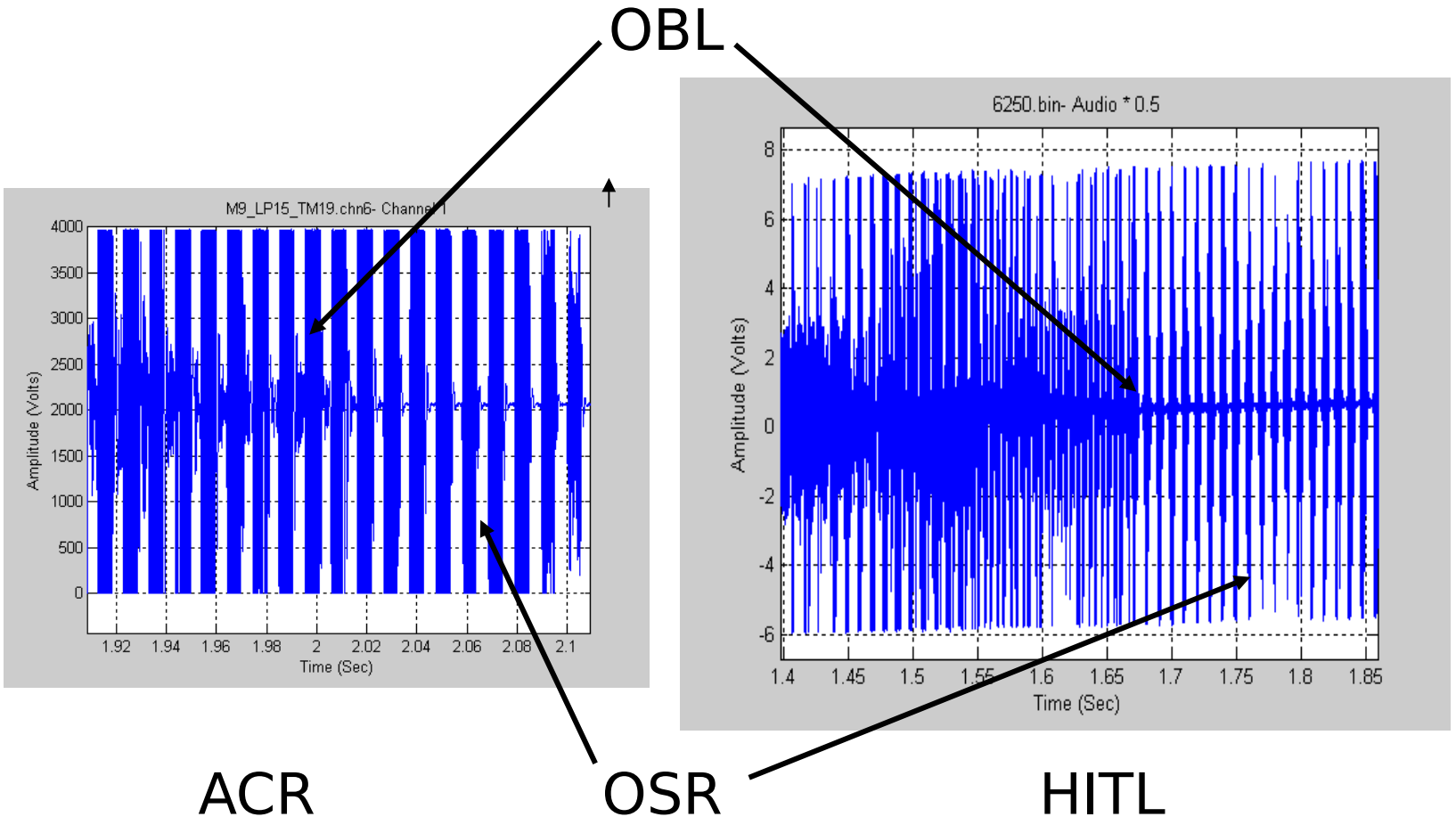


PMD vs. Seeker Signal Frequency

M9 - HITL TC-62 RUN 6250



Optical Break Lock (OBL) Optical Scattering and Reflections (OSR)



Analysis of seeker outputs provided insight into OBL and OSR, and correlation with kinematics

Summary of HITL/ACR

Missile	Event No	HITL TC	Vector Miss Within 95%?	PMD Analysis
	8	22	NO	ACR (300 m) > HITL maximum (250 m)
M2	24	71	YES	ACR and HITL maximum same ~ 230 m
	26	131	NO	ACR within HITL maximum ~ 280 m
M5	15	141	NO	ACR (1557 m) > All HITL runs (< 1400 m)
	20	141	NO	ACR (1330 m) fell within All HITL runs (> 1200 m and < 1400 m)
M7	5	42	NO	ACR nearly same as median ~285 m
	12	151	NO	ACR within HITL maximum ~230 m and > all other runs
M8	7	52	NO	ACR (486 m) is > all but one HITL run
	13	161	YES	ACR final miss (289 m) encompassed by HITL runs
	4	62	NO	ACR ~140 m - minimum of HITL runs ~170 m
M9	14	171	YES	ACR nearly same as minimum ~ 20 m
	27B	192	YES	ACR nearly same second smallest ~290 m
	28B	182	YES, but smaller than HITL minimum	ACR ~100 m - HITL minimum ~ 200 m

HITL Limitations

- **Not a complete (end-to-end) LAIRCM system test**
  - Assumed that MWS and tracker works as predicted
    - Done separately (good results)
  - Results only pertain to laser jamming effectiveness against the seeker and missile response to jamming
  - Demonstrated during ACR
- **Unable to simulate near-simultaneous missile launches**
  - Demonstrated during ACR
- **No treatment of round-to-round variation (threat missiles)**
- **No individual AFEWES threat model validation**

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Validation Tools
assessment

Benchmarking: Excellent tool if “standard” is available

Face Validation: A “must do” but may be subjective

Results Validation: Sufficient results from properly instrumented and representative live-fire often lacking

Sensitivity Analysis: May demonstrate that a particular input to the simulation has very little impact on the outcome

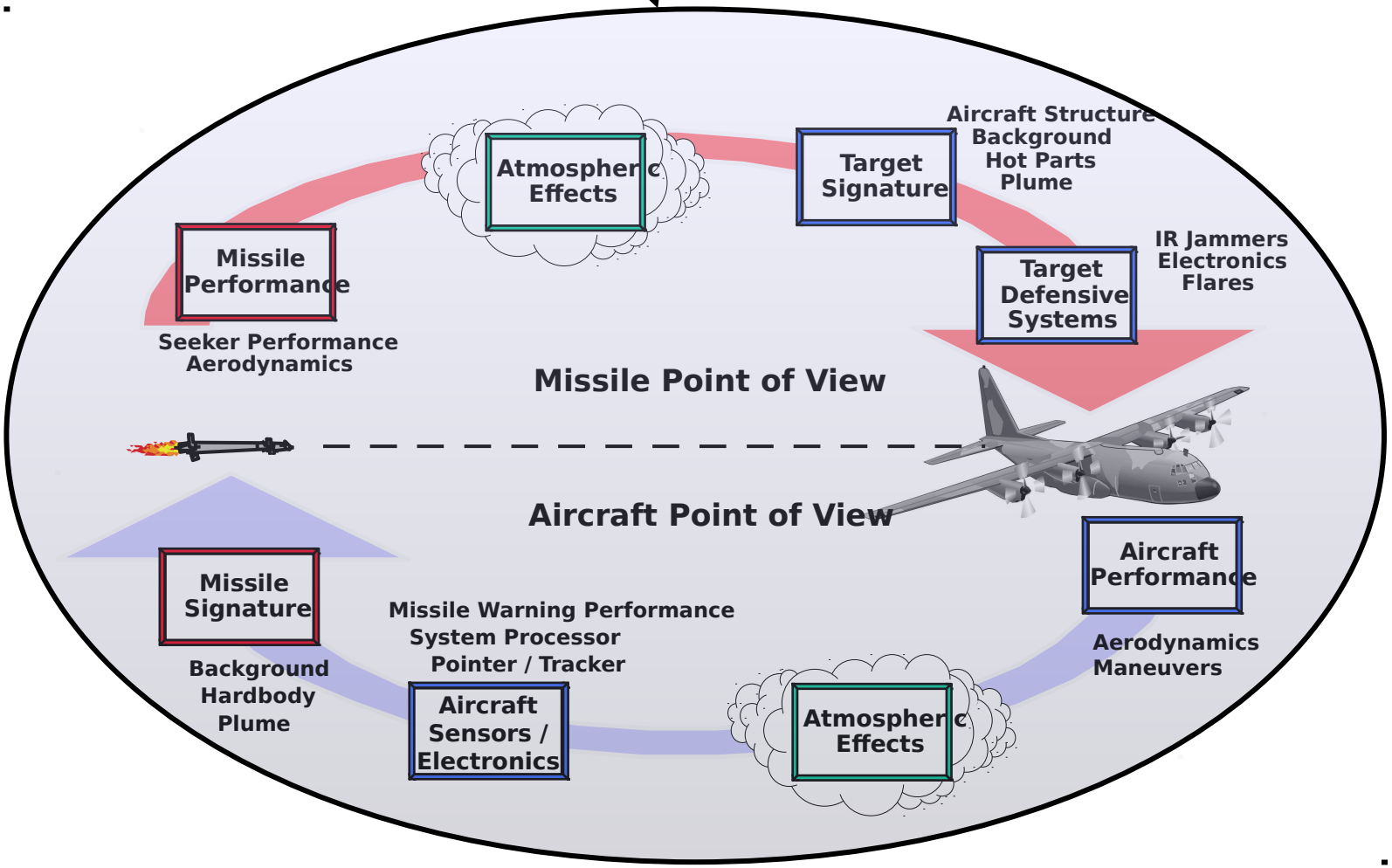
- OR -

if the input <u>does</u> matter, one can appropriately articulate the limitations of the simulation and caveat the results.

IRCM Effectiveness Evaluation

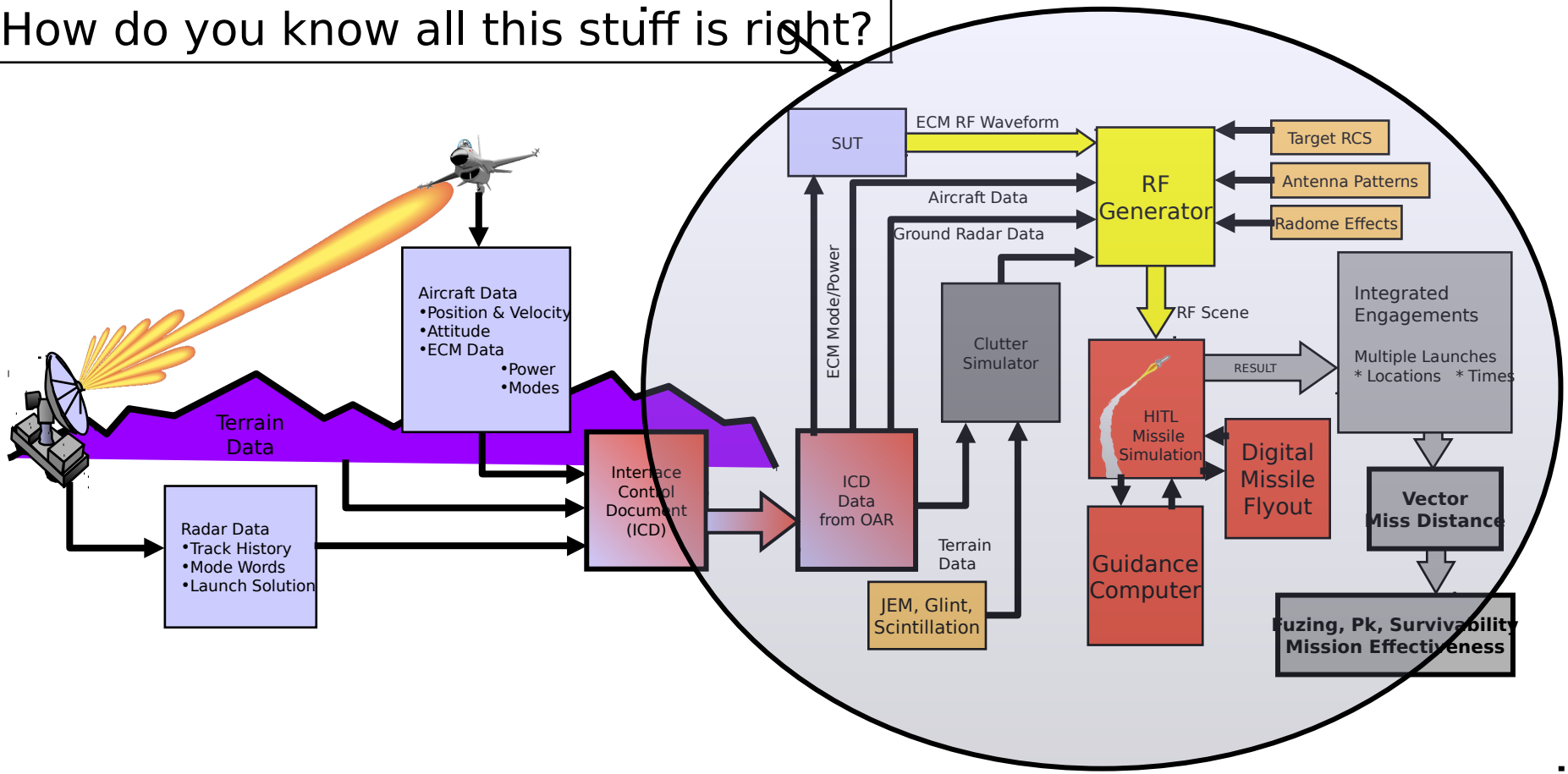
the closed loop

How do you know all this stuff is right?

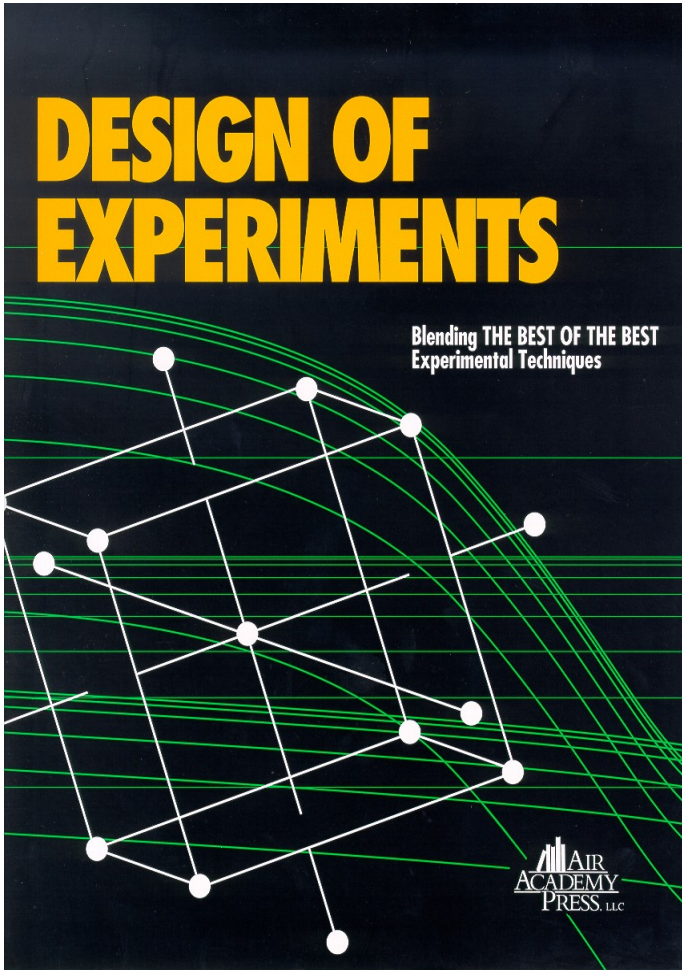


OAR / HITL
integrated test concept

How do you know all this stuff is right?



Design of Experiments (DOE)



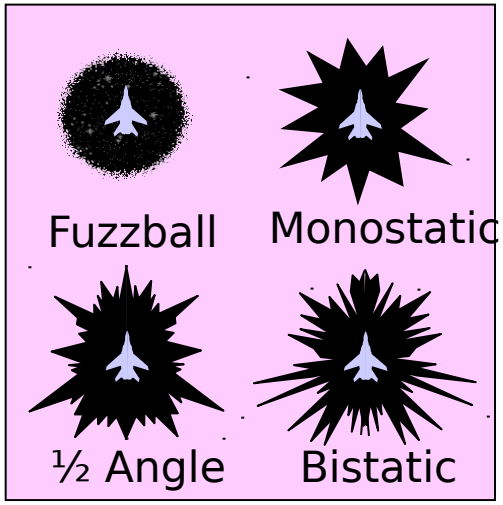
"Experimental design consists of the **purposeful changes of the inputs** to a process in order to **observe the corresponding changes in the outputs**. …a scientific approach which allows the researcher to gain knowledge in order to better understand a process and ***determine how the inputs affect the response.***"

Schmidt and Launsby, authors

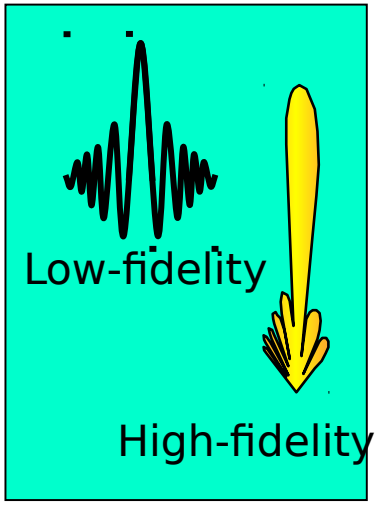
Seeker Aided Ground Guidance

design of experiments factors

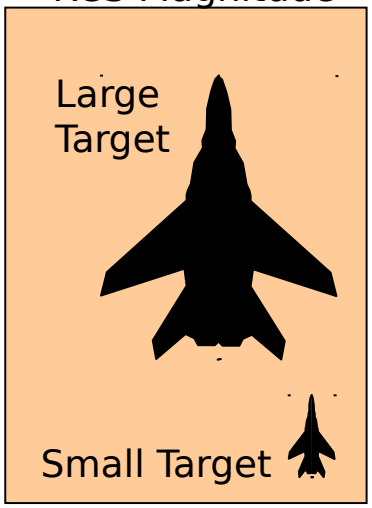
RCS Model



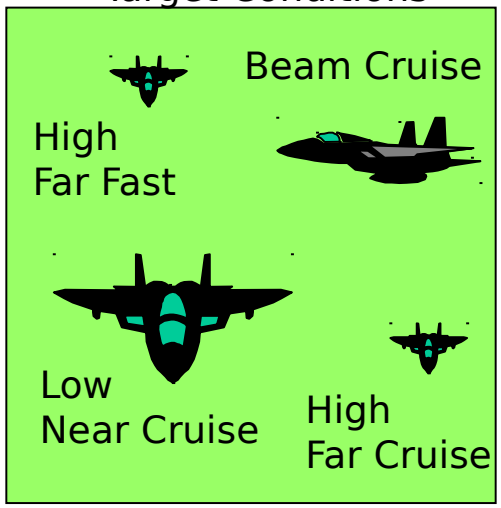
Receiver Antenna

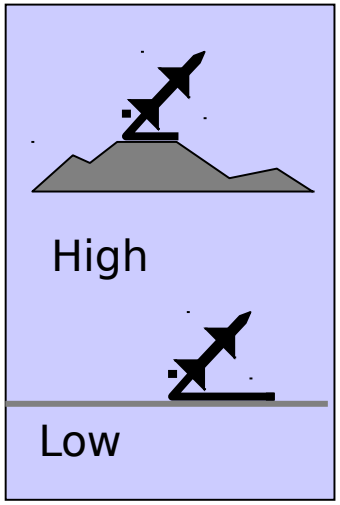


RCS Magnitude

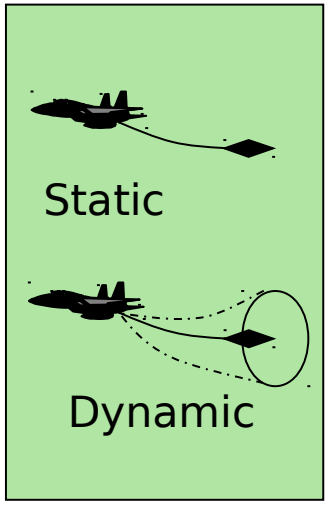


Target Conditions

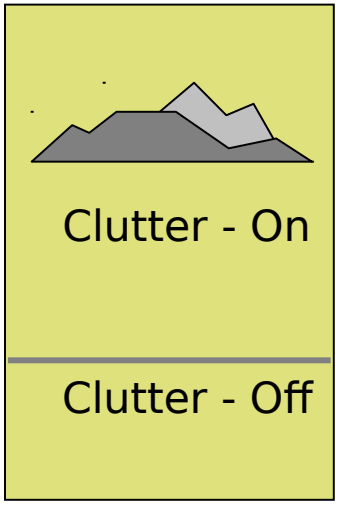




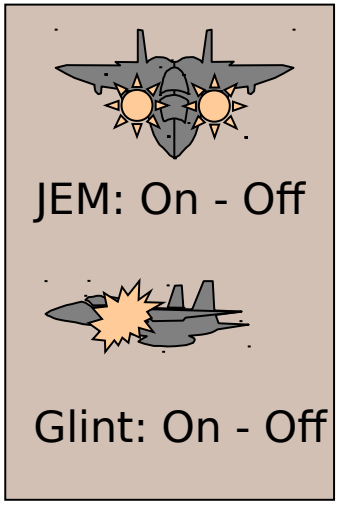
Launch Elevation



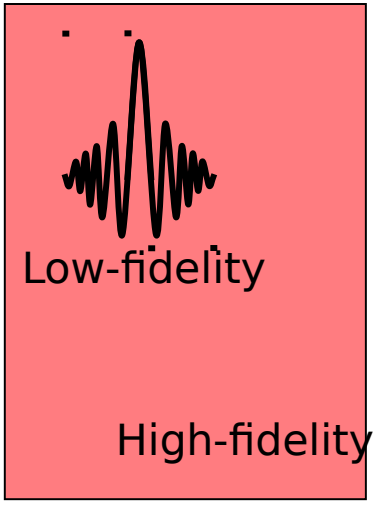
ECM Dynamics



Clutter Model



JEM Glint



ECM Antenna

IR DOE
candidate experimental topics

- [x] Extended vs point source impact on seeker operation
- Fidelity of flyout impact on miss distance (dry and decoy)
- Fidelity of flyout impact on optical break-lock outcome
- [x] Varying specific flyout component (e.g. fin lift coefficient) impact on flyout
- Impact of serial number to serial number variance of missile seeker for various seeker types
- Impact of J/S on engagement outcome for:
  - flares, lamp jammers, laser jammers
- Impact of time-to-go variation due to missile warning performance input
- Impact of laser attenuation due to pointer/tracker inaccuracy
- Impact of “blue sky” versus “realistic” background

Military & Civil Aircraft Applications
Naval IRCM Applications
Ground Combat Vehicle IRCM Applications
Homeland Security Applications

2004 Meeting of the Military Sensing Symposia (MSS) Specialty Group on

INFRARED COUNTERMEASURES

Naval Postgraduate School
Monterey, California
27-29 April 2004

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More Information Related to Sensitivity Analysis

Particularly Reports on Work Conducted by:

DIA Missile and Space Intelligence Center (MSIC)

Air Force Electronic Warfare Evaluation Sim (AFEWES)

Naval Air Warfare Center (NAWC) China Lake

Army Research Lab (ARL)

Will be presented at the MSS IRCM Symposium

www.iriacenter.com

Conclusions

- AFEWES has robust tools for EW analysis… but just one tool in the kit
- One must determine the question to be answered before selecting the tool to be used – required fidelity depends on the question
- Verification, Validation and Accreditation (V V & A) is critical to credible EW effectiveness assessments
- Validation is particularly sticky… few standards and limited credible data for comparisons
- Sensitivity analysis, properly used, can be effective

"a fool with a tool is still a fool"

Questions